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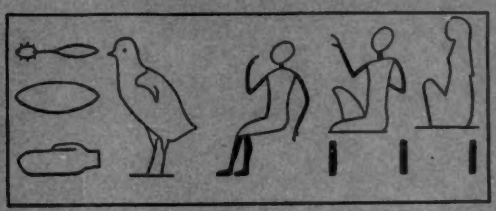
CHILD DEVELOPMENT



Editorial Board

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DEVELOPMENT WITHIN THE FIRST TWO YEARS OF INFANTS PREMATURELY BORN[1]

RUTH T. MELCHER

The majority of studies of infants prematurely born have been concerned with physical rather than mental development. Recently, however, Ypplo (12) has reported 7.4 per cent of more or less gross mental defect among his numerous patients. He also quotes Sarvan who found 8.7 per cent of cases mentally defective among 3174, and Brander who examined 376 prematurely born children of school age by means of the Terman Revision of the Binet-Simon Scale and found 11.2 per cent had an intelligence quotient equal to or less than 70. In this study the parents also were examined and only two cases of mental deficiency were found. Finally, Montserrat (9) working in the Psychological Institute in Vienna examined infants between 24 days and 10 months of age with the Bühler-Hetzer tests (2). He stated that the "normal" range of intelligence quotients for these infants was from 65 to 95, instead of from 90 to 110, as for children born at term.

All of these studies have failed to distinguish between the fact of prematurity per se, and other pathological conditions which do frequently accompany premature birth but are not peculiar to it. Especially the cases of cerebral hemorrhage have not been treated separately. In the recent careful study by Mohr and Bartelme (8) where this distinction was made, an almost normal distribution was found. Looft (6) in his study of rachitic prematurely born children came to the conclusion that the mental retardation which he found was due mainly to the rachitis. Very few of the children in these studies were within the first two years of life, however. Comberg (see 8) also stated that he found in the prematurely born delayed development, but not lasting retardation. Especially in walking and talking, up to 12 months of age these children lagged behind the average. The maximal retardation was in children whose birth weight was less than 1500 gms. At a birth weight over 1600 gms. there was an average delay of 4 months, while at 2000 gms. birth weight, the children reached normal performance.

Gesell (4) presented only one case in evidence for his contention that birth is merely an incident in the maturation pattern, and the age of the prematurely born child must be corrected for the amount of prematurity in reckoning the developmental quotient. He admitted, however, that the discrepancy between age reckoned from birth date and age reckoned from conception might become negligible by school age, and also that in infancy the premature might profit from early exposure to sensory and social stimuli.

PROBLEM

The purpose of the present study was to discover whether differences, either quantitative or qualitative, between prematurely born and full term children within the first two years of life might be shown with especial clarity by means of

[1] A study from the Psychological Institute at Vienna. The author is under obligation to Frau Professor Charlotte Bühler and Frau Dr. Liselotte Frankl for direction in this study, and to the Institute staff for many courtesies.

the Bühler-Hetzer infant tests. Quantitatively the questions were: (1) how do the prematurely born compare with full term children in general intelligence month by month; (2) are there differences in rate of mental growth from month to month among the prematurely born within this early period, and if so at what age is their rate of development most rapid; (3) if they are retarded in comparison with full term children, at what age, if at all, do they catch up? Qualitatively it would be desirable to know: (1) if they are retarded in particular developmental dimensions in relation to others; (2) if there is any general tendency in the pattern of development, and (3) if there are character traits which seem peculiar to these children.

SUBJECTS

The tests were applied to a group of 44 prematurely born infants ranging in age from 1 month and 15 days to 18 months and 25 days. All but two of these children had been cared for after birth in the premature ward of the Reichsanstalt für Mutter-und-Sauglingsfürsorge in Vienna. Access to them was made possible by the cooperation of Dr. Arnulf Meier of the hospital staff. The two exceptions were seen in the ward of the Karoliner Krankenhaus.

Of these 44 children, 3, (6.8 per cent) showed physical symptoms which suggested cerebral hemorrhage. This corresponds remarkably well with the percentage of mental deficiency found in the Scandinavian studies. Two of the three were definitely injured and are not included in this study. In the remaining case the suggestion was slight and indefinite, and the baby was included in the group, with a note as to the doubt.

Ten of the 42, or 24 per cent were examined in the hospital ward. Of these, 5 were within the first three months of life and had not yet been dismissed to their homes; 5 had returned to the hospital after previous dismissal, 4 because of nutritional difficulty and 1 because of illness of the mother. It is important for the results of this study to note that only 5 children in the group had not had the experience of care in their own homes, and these 5 were still very young. Thirteen or 30 per cent were examined in the doctor's office, where they were brought by their parents for a routine follow-up examination, and 19 or 46 per cent were examined in their own homes. No child examined at home or in the ward refused cooperation. Under the unaccustomed conditions of the doctor's office, some cooperated well and apparently were not upset. Others showed fatigue and nervousness resulting from the break in their usual schedule and the trip from home, and possibly did not perform to the best of their ability. When the upset was marked, however, the examiner followed up the child later at home.

In addition to the tests, observation and protocol of the child's activities during a free play period, and conversation with the parents, information concerning each infant was sought from the hospital records. In most instances these contained a description of the birth and neonatel period and a few items of social data. Since the babies were all born either at some other hospital or at home and transferred to the Reichanstalt for special care at periods ranging from a few hours to several weeks the birth data were not always complete. For our purposes, however, the chief interest in the hospital records is to show that

these infants were a reasonably representative sample of healthy though prematurely born children. To this end, the information from the blanks has been summarized in the following statements:[1]

1. There were 3 sets of twins in the group, and 3 other survivors of a twin birth. Two of the latter were the first-born of the pair, and one was the second-born. Only 5 of the families included one other child; one had 2 others, and in 30 the premature infant was the first birth. Six records were lacking. In 3 cases, one previous abortion had occurred; in one case, 2, and in one case 7 spontaneous abortions preceded the birth of the viable infant. In this case the child was brought near term only by special glandular feeding of the mother.

2. The parents, with a few exceptions, were of the skilled laborer or small tradesman class of Vienna. The exceptions included two dentists and one teacher. In 14 cases the home consisted of one room and kitchen; in 17 cases there was a kabinette in addition, and one home visited was a 5-room apartment. In 22 instances it was recorded that only the parents lived in the home; in 5 cases there were 3 adults and in 5 other cases more than 3 adults. The rest were not recorded.

3. Eleven of the babies came to the Reichanstalt on the day of birth; 3 on the day following birth, and 23 at periods ranging from 4 days to 11 weeks.

4. In 12 cases the duration of labor was not recorded. In 5 cases it was more than 14 hours; in 13 cases less than 6 hours, and in 13 cases within these limits. The average length of labor for prima paras is usually considered between 12 and 14 hours, but 11 of the 13 shorter-than-6-hour labors occurred in prima para cases.

5. Asphyxia of the infant at birth was noted only 4 times in the records. No statement was made in 10 instances. In 27 cases the birth was spontaneous, in 5 forceps were used, and in 8 there was no statement.

6. In 17 cases there was mention of overriding of the skull bones or other considerable molding of the head in the birth process. In 18 cases the head was described as well formed and no mention of molding was made. In 5 cases there were no data. Softening of the skull bones (cranio tabes) in the neonatal period was noted in 16 cases. In 15 cases the bones were described as hard and no mention of softening occurred. In 9 cases there was no statement.

7. Icterus in the neonatal period was noted in 14 cases, cyanosis, or blueness around the mouth and nose, in 12 cases.

8. Nutritional difficulty involving loss of weight after the normal initial period of weight loss occurred in 8 cases. This was in every case overcome and the baby gaining well before discharge from the hospital.

9. The following conditions were noted in the group: previously syphilitic

[1] In 4 cases no history of the case could be obtained.

mother, though with negative WAR at the time of the child's birth - 2 cases; spina bifida - 1 case; heart murmur - 1 case; gastric tumor - 1 case; rattle over lung in breathing - 2 cases; attack of tetany - 1 case; possible hydrocephalus - 1 case; somewhat spastic extremities - 2 cases; plexus paralysis - 1 case; rickets - 1 case; marked restlessness, apparently nutritional - 2 cases; naval hernia - 3 cases. Minor ailments such as colds and slight gastric disturbances occurred in a number of cases.

Besides having a longer period of scientific feeding and observation than the average infant after birth, the children cared for at the Reichanstalt were followed up by the hospital authorities and their parents instructed as to their care. Moreover, a certain amount of selection occurred in the cases studied here in that all of the parents whose children had been dismissed showed sufficient interest in their welfare to cooperate with the hospital's follow-up program. With respect to intelligent care, therefore, the fact of prematurity probably set them above average.

TEST RESULTS

The quantitative test results are shown in Table 1. Column 1 gives the number of the case; Column 2, the life age of the child; Column 3, the developmental age obtained from the test performance; Column 4, the developmental quotient obtained by dividing the developmental age by the life age, and Column 5, the birth weight of the child where this was obtainable. At the end of the table the data from the 2 cases of cerebral hemorrhage are added. Case 2 is the doubtful case mentioned in the previous section. The three cases of nutritional difficulty mentioned in the notes are instances where the child had returned to the hospital for this cause and was examined in the ward, after a previous dismissal. The notations used throughout to express the child's age are to be read as follows: Case 1. L.A. 1 month and 15 days; D.A. 1 month and 15 days; D.Q. 100. Case 26. L.A. 1 year, 2 months and 1 day; D.A. 1 year, 1 month and 15 days; D.Q. 96.

The table shows that within the first three months there was on the average considerable retardation. Unfortunately there were no cases in the fifth month of life. From the sixth month on, the averages were over 100.

Figure 1 shows in graphic form the distribution of D.Q. scores obtained from the examinations. This is a normal distribution, in contrast to that obtained by Montserrat.

Figure 2 shows that there is a marked extension in the upper limit of the distribution of each successive age group up to the 11-14 months period. The figure also shows that there was not much difference in the lower limit of the distribution after the first three months.

Up to this point no account has been taken of the birth weight of the infant nor the length of the period of gestation. For the 39 cases in which birth weight was obtained, the correlation between birth weight and D.Q. was .41 $\pm$ .08. (Pearson product-moment method.) Moreover, the average D.Q. of the 22 children having birth weights of 2000 gms. or less was 102.7, while the average for the 17

TABLE 1

Life ages, developmental ages, elopmental quotients and birth weights of 44 prematurely born infants, examined with the Bühler-Hetzer infant tests.

No.	L.A.	D.A.	D.Q.	B.W.	Notes
1.	0; 1+15	0; 1+15	100	2800 gms.	
2.	0; 1+16	0; 1+ 3	71	2800	Possible hemorrhage
3.	0; 3+ 0	0; 3+ 0	100	2150	
4.	0; 3+ 5	0; 2+24	88	1950	
5.	0; 3+12	0; 3+ 0	88	2130	
6.	0; 3+17	0; 3+ 3	90	2000	
7.	0; 3+22	0; 3+ 0	80	--	Nutrition difficulty
		Average	88.14		
8.	0; 5+20	0; 6+ 6	109	2700	
9.	0; 6+ 3	0; 6+15	106	1800	
10.	0; 6+13	0; 6+21	104	--	
11.	0; 7+ 9	0; 7+12	101	1770	
12.	0; 7+19	0; 8+ 9	112	2050	
13.	0; 8+21	0; 8+ 9	95	--	Nutrition difficulty
14.	0; 8+27	0; 9+18	108	1800	
15.	0; 8+26	0; 8+24	99	1900	
		Average	104.25		
16.	0; 9+ 8	0;11+18	127	1950	
17.	0; 9+14	0; 9+12	99	1500	
18.	0; 9+15	0; 9+15	100	1350	
19.	0; 9+25	0; 9+18	98	1400	
20.	0; 9+25	0;11+24	120	2700	
21.	0;10+ 0	1; 0+ 3	121	2050	
		Average	110.83		
22.	1; 0+ 0	0;10+24	90	1690	
23.	1; 0+ 3	0;10+18	87	1200	
24.	1; 1+ 9	1; 1+ 9	100	1800	
25.	1; 1+ 9	1; 1+ 9	100	1680	
26.	1; 2+ 1	1; 1+15	96	1900	Anaemia
27.	1; 2+ 6	1; 9+18	159	2400	
28.	1; 2+ 9	1; 3+18	109	2180	
29.	1; 2+ 9	1; 2+ 3	99	1530	
30.	1; 2+15	1; 4+ 6	112	2130	
31.	1; 2+15	1; 7+15	134	2800	
32.	1; 2+15	1; 4+15	114	2230	
33.	1; 2+16	1; 8+12	140	2250	
34.	1; 2+23	1; 8+ 3	136	1980	
		Average	113.5		
35.	1; 3+ 5	1; 9+ 0	138	1850	
36.	1; 3+22	1; 4+24	108	2500	
37.	1; 3+25	1; 3+ 3	95	1280	
38.	1; 4+ 3	1; 6+ 9	113	1900	
39.	1; 4+ 5	1; 8+ 3	124	2000	
40.	1; 4+ 7	1; 4+ 6	99	830	
41.	1; 5+24	1; 8+ 3	112	1600	
42.	1; 6+25	1; 7+24	105	2019	Nutrition difficulty
		Average	111.75		

TABLE 1 - Continued

No.	L.A.	D.A.	D.Q.	B.W.	Notes
43.	0; 6+ ?	0; 0+24	(13)		Cerebral hemorrhage
44.	0;11+ 0	0; 8+18	81		" "

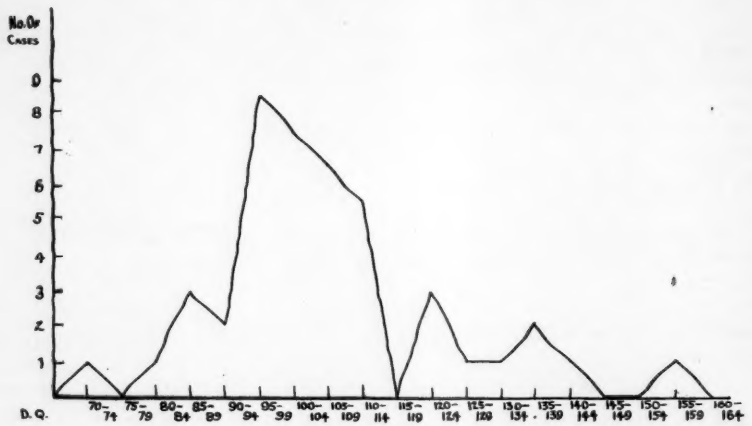


Figure 1. Distribution of developmental quotients of 42 prematurely born infants under 19 months of age examined by the Buhler-Hetzer infant tests.

children having birth weights between 2000 and 2800 gms. was 113.3. The low average D.Q. of the children between 1 and 5 months of age is not due to any bunching of the lower birth weights within this age period, however, since only one of the 6 had a birth weight less than 2000 gms.

Attempts to divide the children as to length of gestation period are always questionable because of the uncertainty. In only 29 cases in this study was the length of term stated. Of these, 10 were said to be 7-months babies, 12 were 8-months, and 7 were born in the 9th month, only a few weeks early. The means of the D.Q.'s are: 7-months, 107.9; 8-months, 105.16; 9-months, 111.7. Obviously the birth weight is a much more important factor than the probable length of gestation.

Quantitative analysis of these data, then, showed the following facts in regard to these healthy, prematurely born children:

1. The total distribution of D.Q. scores was normal, and of the same range which might be obtained among a group of children born at term.

2. The mean of the D.Q. scores of the children below 5 months of age was slightly below the range for healthy, normal, full term children. The mean of the scores of children between 5 and 9 months of age was average. From 9 to 12 months there was another rise in the mean for this group. Thereafter the fluctuations did not appear large enough to be of any significance.

3. There was a low positive correlation between the birth weight and the developmental quotient within the first two years. Furthermore, the mean of the D.Q.'s for children having birth weights of 2000 gms. or less was considerably lower than that for children whose birth weights were over 2000 gms.

4. The mean D.Q. for the children born only a few weeks early was slightly higher than that for the 7- and 8-months babies, but considering the uncertainty of this classification and the small number of cases in each group, this did not appear to be significant.

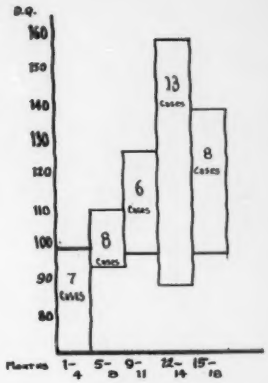


Figure 2. Distribution of developmental quotients in successive age groups of 42 prematurely born infants examined by the Bühler-Hetzer tests.

Even more interesting than the quantitative aspects of this study were the qualitative features, which were brought out with especial clarity by the use of the Vienna scale. The graphic profiles and a statistical analysis of the relative frequency with which tests were passed in the different dimensions have been used to demonstrate the peculiarities found in this group.

The number of plus and minus scores for each test was reckoned. For each child only those successes and failures within the range where both occurred were counted. Table 2 shows the result of this summary. Column 1 gives the testing dimensions found in the Bühler-Hetzer tests. Column 2 shows the number of single tests given in this dimension. There are not the same number of tests in each dimension of the scale, hence the wide differences in the number given. Column 3 shows the number of tests passed, and Column 4 the percentage passed of the total number of tests given in that dimension.

Figure 3 shows in graphic form the percentages given in Column 4 of Table 2.

The fact that sensory reception stands first may be only an indication that the responses to these tests require less motor control than do those in the other dimensions.

Closer analysis showed further specific retardations. Certain tests were failed especially often. These are shown in Table 3. Column 1 gives the test dimension; Column 2 gives the division within this dimension; Column 3, the series number designating the month of life within which the test occurred; Column 4, the

TABLE 2

Number of tests given, number and percentage passed, and number and percentage failed in each dimension.

Dimensions	Total tests given	Total tests passed	Percentage of tests passed
Sensory reception	133	101	76
Bodily movements	298	133	45
Social responses	164	103	63
Learning	218	144	66
Activity with materials	113	66	58
Mental production	101	45	45

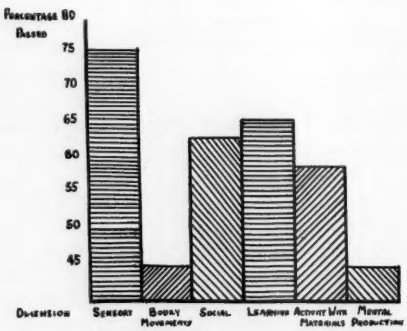


Figure 3. Percentage of tests passed in each dimension of the Bühler-Hetzer infant scale by 42 prematurely born infants.

test number within this series; Column 5, the response required for passing the test; Column 6, the total number of times this particular test was given and Column 7, the number of times that it was failed. Column 8 gives the age range of the children who failed the test. The series numbers correspond to the month of life age of the child up through Series VIII. After that more than one month is included in the test series. Series XI includes the period from 12 to 15 months of age, and Series XIII, the period from 18 to 24 months. Taking for an example Test 2 in Series XI, which requires the bodily control necessary for standing alone, the table shows that of 11 children between the 11th and 17th month of life who were given this test for the first quarter of the second year, 10 failed to pass it. All of these children had passed other tests in this series, or this

TABLE 3

Tests usually failed when occurring within the test range of the child.

Dimension	Division	Series	Test	Requirement	Times given	Times failed	Age range months
Bodily movements	Bodily control	I	9	Lifting head when prone	4	4	2nd-4th
"	"	IV	6	Lifting head and shoulders when prone	4	4	4th
"	"	IV	7	Moving arms and legs when prone	4	4	4th
"	Overcoming hindrance	VII	4	Freeing self from cloth over head when prone	6	6	5th-10th
"	"	VIII	2	Freeing self from cloth over head when sitting with support	8	6	7th-10th
"	Bodily control	XI	2	Standing alone	11	10*	11th-17th
"	"	XIII	1	Climbing onto a chair	11	11	15th-19th

*Seven of these failures were by children 14 to 16 months old.

failure would not be counted here, since it would be considered above the range of possible success for this child.

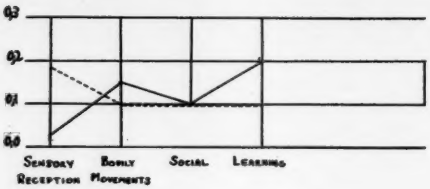
These specific tests in the dimension of bodily movements were given, altogether, 50 times, and failed 47 times, or 95 per cent of the times that they were given. Inspection shows that they all involve postural control, particularly control of the head in the early months, later in locomotion. No grasping tests appear. The developmental profiles were used to convey a graphic impression of each child's relative success in the different dimensions. In the blanks used by the Psychological Institute, the space between the horizontal lines represents the age period of the test series. On the vertical lines, the tests within this period in the dimension indicated are represented by small circles. One counts the number of tests passed by the child and places him at the corresponding level in each dimension.

The developmental profiles drawn from these cases showed only one trend persistent throughout the series. This was the upward slope from the dimension of bodily movements to that of social responses. In the 42 cases, there were only 5 instances of a downward slope, 10 of a horizontal line, and 27 of the upward slope. No other trend so consistent could be shown.

In the 4th month the tendency was for children to score at average in sensory reception, considerably below average in bodily movements, and at average or above

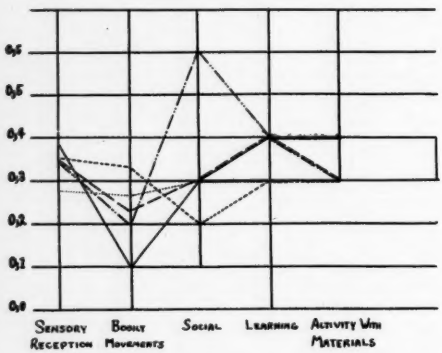
Developmental profiles of Cases 1 and 2 in the second month of life.

Case 1 ----
Case 2 ____



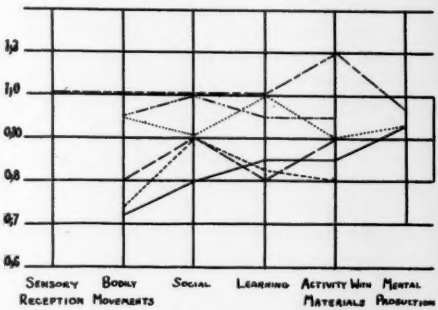
Developmental profiles of Cases 3 through 7, in the fourth month of life.

Case 3 ----- Case 5 ____ Case 7 ____
Case 4 ..... Case 6 ____



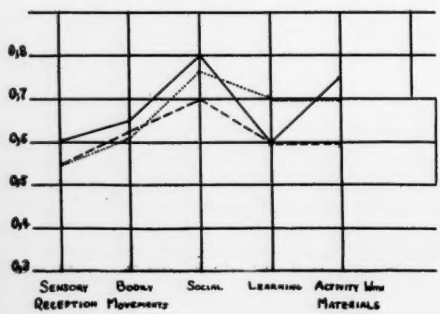
Developmental profiles of Cases 16 through 20 in the 10th month of life and Case 21 in the 11th month of life.

Case 16 ____ Case 18 ------- Case 20 .....
Case 17 ____ Case 19 ____ Case 21 ____



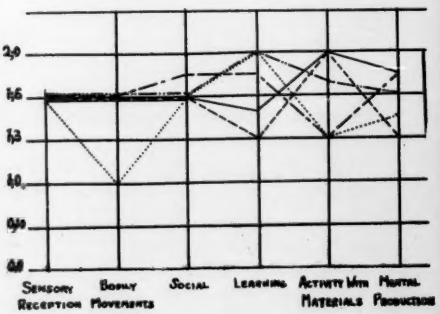
Developmental profiles of Case 8 in the sixth month of life and Cases 9 and 10 in the seventh month of life.

Case 8 ____ Case 9 ____ Case 10 ____



Developmental profiles of Cases 38 through 40 in the 17th month of life, Case 41 in the 18th, and Case 42 in the 19th months of life.

Case 38 ____ Case 40 ..... Case 42 ____
Case 39 ____ Case 41 ____



in the other dimensions. In the 6th and 7th months, the three cases plotted were below average in the dimension of sensory reception and about average in bodily movements. Why they should have fallen below the average in sensory reception at this age level is not clear. Reference to the tests shows, however, that the majority of the tests of bodily movements at this level involve grasping, and consequently allowed these children to score better than at other levels. In fact, the degree to which bodily movements were retarded varied from age group to age group. At the periods when the major forward steps in postural control should appear (sitting alone: 9th month; standing alone and walking: first half of the second year) the greatest retardation is demonstrable.

With the exception of the first two dimensions there appeared to be as wide individual differences among these children as among children born at term. In every age period the deviations above and below the average in social responses, learning, and activity with materials balanced each other, making the midpoint of each distribution fall near the midpoint of the life age distribution.

The numerical analysis showed that the percentage of tests passed in the dimension of mental production was as low as that in bodily movements. This does not show clearly in the profiles. However, in the majority of age groups the range of distribution of the scores in mental production was narrower than in the three preceding dimensions, and in two groups (Profiles 6 and 9) the whole distribution fell below the group range in life age.

QUALITATIVE NOTES

During the observation period, the examiner made notes as to the quality of the child's behavior. These notes were classified under twelve headings, which were defined as follows:

1. Passive: lack of bodily activity in response to stimuli usually calling it forth. In babies 1 to 4 months old, the stimuli were mainly change of bodily position. In older children the stimuli were mainly the test materials.

2. Active: Sustained activity, whether vigorous or quiet.

3. Positive reactions: acceptance of and approach toward materials or persons.

4. Negative reactions: continued refusal of materials and social advances.

5. Inhibited: hesitancy and tension in the acceptance of materials or social advances, usually overcome after better acquaintance with the situation.

6. Socially independent: friendly, but social stimulus not necessary for continued contented activity.

7. Socially dependent: Social stimulus preferred to materials and needed for contented activity.

8. Responsive to social advances: friendly when social stimulus is presented.

9. Makes social advances: smiles, vocalizes, offers toys, or otherwise initiates social interchange.

10. Unresponsive socially: seems unaware of other individuals.

11. Affective reactions strong: strong crying when displeased; strong activity, motor or vocal, when pleased; strong tensions in temper or fear, and the frequent occurrence of these responses.

12. Affective reactions moderate: absence of the above displays.

The distribution of the cases under these headings is given in Table 4. In a number of cases observational notes were lacking: consequently the number of cases under the categories of opposites do not total 42.

Of the 14 babies described as passive, 7 were the first 7 cases, i.e. the infants less than 4 months old. The other 7 are distributed throughout the remainder of the group.

TABLE 4

Quality of response during the examination period.

Quality	No. of cases
Passive	14
Active	20
Positive reactions	25
Negative reactions	8
Inhibited	4
Socially independent	12
Socially dependent	19
Responds to social advances	16
Makes social advances	21
Does not respond socially	3
Affective reactions strong	15
Affective reactions moderate	25

APPEARANCE

Peculiarities in the appearance of the child at the time of the examination were noted when present. These are listed in Table 5.

In 20 cases, no peculiarity was present. The birth weights of these averaged 2147.4 gms.

In 14 cases some peculiarity in the child's appearance was recorded. The

TABLE 5

Peculiarities of appearance found among 42 prematurely born infants.

Peculiarity		No. of cases
Head slightly flat in back		3
Head very flat in back		5
Head asymmetrical:	pushed right	2
	pushed left	3
	bump in back	3
	groove in back	1
Head appears very wide above ears		5
Forehead high and prominent		3
Eyes prominent		3
Skin puffy under eyes		4
Anxious expression		2

birth weights of these cases averaged 1617.4 gms.

Nine of the 14 cases mentioned above occurred among the 21 children examined in the first year of life; 7 in the 21 cases examined in the second year of life.

SUMMARY

1. Forty-two healthy prematurely born infants were examined by means of the Bühler-Hetzer infant scale. Hospital records, protocols of spontaneous activity and observation notes furnished further information concerning each child.

2. Quantitative analysis of the tests showed that these infants lagged behind the average for children born at term up to five months of age, but scored within average limits thereafter.

3. There was a low positive correlation between birth weights and developmental quotients.

4. Qualitative analysis showed these children to be retarded, on the average, in postural control up to 18 months of age, and no children older than this were tested.

5. The personality traits predominating in the group were: positive reactions, dependence upon social stimulus and response, and rather moderate affective reactions. The moderate affective reactions may reflect a type of passivity not included in the "passive" classification as defined in this grouping. As a whole, they were gentle babies.

6. Children whose birth weights were below 2000 gms. were more likely to show some peculiarity of appearance, persistent into the second year of life, than

those whose birth weights were above 2000 gms.

CONCLUSION

The above results agree in the main with the findings of Looft, Comberg, Bartelme, and others who found that prematurely born children catch up with children born at term in a relatively short time, providing they are healthy. This is somewhat dependent upon the birth weight of the child. The Bühler-Hetzer tests demonstrated the normal general development and made possible analysis of the qualitative aspects of their performance in a definite manner. The results of this analysis are in agreement with Gesell's findings only in so far as he postulated that the prematurely born might be more advanced in sensory reception and in social responses than in some other dimensions.

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A RATING SCALE OF THE VIGOROUSNESS OF PLAY ACTIVITIES OF PRESCHOOL CHILDREN [1]

EVALINE FALES

PROBLEM

Within recent years the play of preschool children has received considerable attention from investigators. Most of the studies have been concerned with play interests of children as observed by choice of materials and length of time spent with materials in a free play situation.

The vigorousness of the play activity has sometimes been judged on the basis of the type of equipment used, but there has never been any very objective and accurate method of measuring the vigorousness of play. It was the purpose of this study to make a rating scale by which the vigorousness of preschool children's play activities could be measured and then to apply this scale in studying sex differences. The study of sex differences will be reported in a later article.

THE RATING SCALE

It was decided to construct a rating scale of the vigorousness of preschool children's play activities by using the mean opinions of expert judges. This method is frequently used in making quality scales and gives rather high consistency as measured by the correlation between the judges' ratings.

The List of Activities

A detailed list of children's activities in the preschool play situation was compiled on the basis of careful observation and diary records. When taking the diary records, the observer took care to list a new item when the apparent vigorousness of an activity changed. Thus, riding a tricycle slowly on the lawn is a different activity from riding it slowly on the pavement. In this way the scale permits great differentiation. No items relating to routine activities such as removing wraps, having orange juice, etc. were included in the list.

The final list of play activities contained 651 items. It was mimeographed and cut apart so that each item was on a separate slip of paper, to facilitate sorting and arranging according to vigorousness. A set of items was sent to each judge with a chart for recording the results, together with directions asking him to place the activities in fifty groups with respect to their vigorousness for nursery school children, putting the most vigorous activities in Group 50 and the least vigorous in Group 1. In comparing vigorousness the judges were asked to consider each activity as engaged in for the same period of time.

[1] This study originated at Mills College. Supplementary work has been done at the Iowa Child Welfare Research Station, State University of Iowa, Iowa City, Iowa.

The Judges

The experimenter chose thirty-two judges who through their training and experience should be competent to rate these activities with the minimum amount of error. Arranging the 651 activities into fifty groups according to their vigorousness is a task which takes from ten to sixteen hours. Results were received from thirteen judges. The ratings of three were discarded because two had not completed the ratings and one had not understood directions.

The ten judges whose ratings were finally used consisted of three psychology professors who were familiar with the preschool, one preschool supervisor, one instructor in physical education who was acquainted with preschool activities, and five graduate students taking work in preschool education. All were well qualified to rate the activities.

Treatment of the Results of the Judges

The ratings of the judges were tabulated and averaged. For each item on the scale the mean group number representing the vigorousness level in which the ten judges had placed the activity was considered the vigorousness of that activity. Since the number of items rated and the number of categories was the same for the ten judges, it was not necessary to change the vigorousness ratings from terms of relative position into measures of unit of amount.

Taking into consideration the probable differences in step intervals between the vigorousness levels on the scale by converting the per cent of times each item was rated more vigorous than each other item into probable error differences between the items would make the scale a little more accurate, but the vast amount of time that this would take did not permit this. Treating the step intervals as if they are equal probably has such a random effect that it does not seriously influence the results.

Distribution of the Activities According to Vigorousness

The activities when grouped according to vigorousness tend to form a normal distribution when the results of the ten judges are used, though the distributions of the individual judges show considerable variation (Figure 1).

Agreement of the Judges

In order to find the consistency of the judges in rating the activities, the coefficient of correlation was found between the mean vigorousness ratings of five of the judges against the ratings of the other five on all of the activities. This coefficient of correlation was .90, which shows that the judges agreed highly in their ratings.

Use of the Rating Scale

The rating scale was used to classify the data, consisting of detailed diary records including each activity in which a child engaged, together with the number

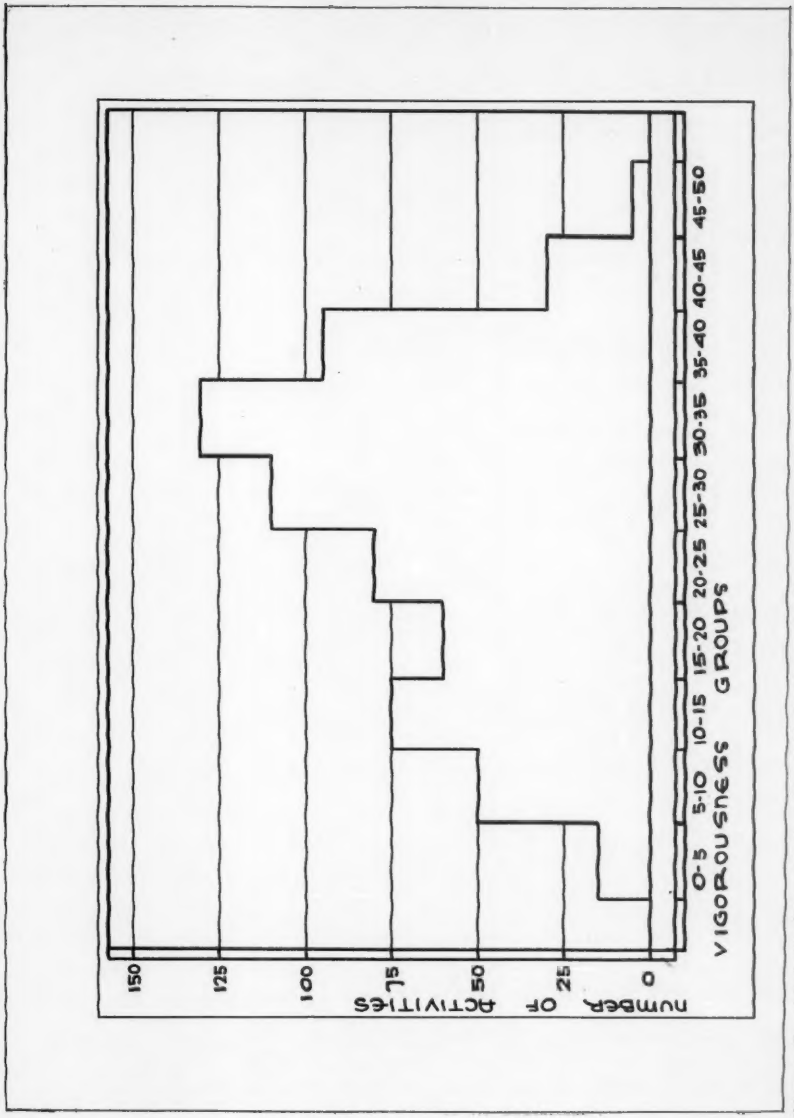

Figure 1. Distribution of the 851 Activities Into Vigorousness Levels as Rated by the Mean of the Ten Judges

of seconds spent at the activity. The diary records were classified by taking each item in the record, finding its duplicate on the rating scale, and multiplying the number of seconds spent as shown on the record by the vigorousness of the activity as indicated on the scale. This product was called the multiplied score, and the sum of the multiplied scores divided by the number of seconds represented was the vigorousness score. Dividing the sum of the multiplied scores by the number of seconds makes it possible to compare vigorousness scores obtained from observations of different length. The vigorousness score can also be compared with individual items on the scale. However, in doing this it must be kept in mind that the child took part in activities both more and less vigorous than the mean score, probably participating over a large range of vigorousness levels.

Following is a short sample of a child's record representing one minute of observation which has been classified:

Item Number	Activity	Time, Seconds	Corrected Multiplier	Vigorousness	Multiplied Score
569	Walking, carrying ball	8		20	160
438	Sitting on ball balancing	7		13	91
537	Standing	2		5	10
568	Walking	3		18	54
560	Running	2		33	66
569	Picking up ball; walking, carrying it	4		20	80
33	Climbing up the steps of the slide one step at a time carrying ball	7	11	31	341
538	Standing at top of slide while ball rolls down chute	3		10	30
69	Rapidly climbing down the chute of the slide	5		37	185
560	Running	11		35	353
568	Walking	18		18	144

The list of activities of the rating scale could be presented in one of two ways. The activities could be listed in their vigorousness levels or they could be listed in categories according to the type of activity, with the vigorousness score for each item. Although the first order of presentation is of interest because it is easy to see items in their comparative vigorousness, the latter order of presentation is necessary in order to make the list of items usable as a rating scale. For this reason the list is presented in this way.

Reliability of the Rating Scale

In order to determine the reliability of the scale, two experienced recorders took data simultaneously. Thirty-four five-minute observations were made. Although the records taken by the two observers showed discrepancies, when they were classified by the rating scale and vigorousness scores were found the correlation between the scores of the two observers was .98 ± .006.

Corrected Multipliers

There is a certain type of item which cannot be scored in the manner just described -- those activities which are self-limiting and more vigorous the less time that it takes to complete them. In this case, it would obviously be wrong to multiply the time by the vigorousness because the multiplied score would be greater the slower the activity. The following example, item 576, walking up stairs one step at a time, makes this clear:

Time, Seconds	Vigorousness	Multiplied Score
6	23	138
5	23	115
4	23	92
3	23	69
2	23	46

If a child took six seconds to walk up the stairs, his total vigorousness for that act would seem to be three times as great as if he had gone up the stairs in two seconds, a performance which obviously would be more strenuous. For these items it was decided to use a system of reversing the time, that is of tabulating all of the time which it took to complete an act, reversing it, and in each case multiplying the vigorousness not by the time but by a corrected multiplier obtained by reversing the time. All of the records, two forty-minute observations for each of thirty-two children, were used in this tabulation. Below is an example of this:

Time, Seconds	Time Reversed	Vigorousness	Multiplied Score
6	2	23	46
5	3	23	69
4	4	23	92
3	5	23	115
2	6	23	138

This system of direct reversal, however, proved to make too great a correction. For this reason multipliers were arranged which would still make the multiplied score greater the less time the activity took, but not as much greater as the simple reversing made it. This was done by finding the median actual time for the

activity and establishing corrected multipliers around it, the multiplier becoming greater as the actual time decreased. To do this it was necessary to do a great deal of experimenting in order to get the multiplier appropriate. The corrected multipliers were tested by multiplying them by the vigorousness of the activity and comparing the product with multiplied scores of other activities engaged in for the same number of seconds. The intervals between the corrected multipliers become greater as the time gets smaller because a difference of one second is more significant in short time periods than in long periods. Following is an example; again item 576, walking up stairs one step at a time, is used:

Time, Seconds	Corrected Multiplier	Vigorousness	Multiplied Score
6	3	23	69
5	3.5	23	80.5
4	4	23	92
3	4.5	23	103.5
2	5	23	115

These corrected multipliers are valid only if the same unit of work is finished in each case. In cases where this is not so, it is necessary to know what proportion of the activity has been completed and to make a correction accordingly. This is discussed later.

For some of the activities which need corrected multipliers there are few data in the diary records. The multipliers for these were made by consulting the time and the multipliers for similar activities which have more data.

Of the 651 activities on the rating scale, there are 113 which are undoubtedly the type which require corrected multipliers. Besides these there are 154 which had to be considered very carefully before a decision could be made. Each of these items was questionable for one of the following reasons:

1. Although the activity was self-limiting, it was seldom completed before the child went to something else.

2. The factor of gravity caused some question. For example, in climbing down the chute of the slide, is it more vigorous to go fast or slowly?

3. The time interval did not vary enough to make corrected multipliers of any value, as in jumping, kicking, and throwing.

4. The activity was apparently more difficult the more slowly it was done (chinning).

Each one of the questionable items was considered carefully and a decision made as to whether it should have corrected multipliers. It was decided that for ninety-seven of these items this would be necessary.

Special Problems in Making the Tables of Corrected Multipliers

In making the tables of corrected multipliers some special problems arose.

1. Some of the activities are stated in such a way that they include two activities, perhaps of different vigorousness. Only the ones for which we have data in the diaries need be considered. Following are these items:

1	Climbing up and down one step of the jungle gym
2	Climbing up and down two or more steps of the jungle gym
159	Climbing in or out of sand box
324	Climbing in or out of wagon
607	Climbing on or off sawhorse
608	Climbing in or out of packing box
609	Climbing on or off packing box
610	Climbing on or off fence
611	Climbing up and down side of porch
612	Climbing on and off window sill
614	Climbing on and off chair or piano bench

In items 159 and 608 both parts of the activity are practically identical in vigorousness, so these were treated in the same way as any other activity with corrected multipliers. For items 1, 2, 609, and 612 a different system was used. It seems quite probable that the climbing down in these activities is less vigorous than the climbing up. The data were taken in such a way that separate times were recorded for each part of the activity, that is, climbing on the packing box was recorded separately from climbing off in item 609. In these cases the times were tabulated separately for each part of the item and separate tables of reversed multipliers were made for each part. The median for climbing on was greater than for climbing off, so that although the same vigorousness was used, the total multiplied score for climbing on in a given length of time was greater than for climbing off in the same length of time. For items 607, 610, 611, and 614 it was not necessary to make separate tables for each part of the activity because in practically every case both parts of the activity were carried out when one was begun.

2. In the vigorousness scale some of the activities are broken up to make two separate items, one for doing the act slowly and one for doing it rapidly. For example:

Item Number	Activity	Vigorousness
94	Slowly walking up incline board	32
95	Rapidly walking up incline board	33

These two items have different vigorousness scores. After tabulating the time taken for completing these activities, there was the question of determining the dividing point between doing the act slowly and doing it rapidly. It was decided

to divide it at the median, using the vigorousness score for doing the activity slowly for all time above the median and for doing it rapidly for all time below. Then the problem arose whether to correct all of the multipliers by reversing around the median or to reverse around the median for completing the activity rapidly and that for completing it slowly. After having tested each method, it seemed more satisfactory to do the former. It was necessary to make a change in the series of corrected multipliers at the median in order that there would not be too great a difference between the multiplied scores of the slowest of the rapid times and the most rapid of the slow times.

3. In a few cases the child only partly completed a self-limiting activity. In these cases the experimenter used the multiplier which would be appropriate if the child had completed the activity at about the same rate of speed. If the child walked halfway up the stairs in three seconds, for example, the corrected multiplier which goes with six seconds was used.

4. Several times activities which ordinarily would be reversed were made continuous by the children. For example, a child climbed up the fence, part way down, up a little way, then down again, continuing fence climbing for some time but not completing the activity of "climbing up the fence" before climbing down. In cases like this, the real times were used rather than the corrected multiplier as if the items were the kind that should not be reversed.

In a few cases children tried to complete an activity for some time without succeeding. For example, a child tried to climb onto a large packing box but could not do so. In cases like this, also, the times were not corrected but the item was treated as one of the nonreversible kind.

Of the 651 activities on the rating scale, 205 are the type which apparently need corrected multipliers. Only fifty-six of these items appear in the diary records. These appear 1,023 times and represent a total of 5 per cent of the total time covered by the records. The method of corrected multipliers is not as objective as the other aspects of the rating scale and may not be entirely accurate, but these items represent such a small proportion of the total time that the effect is probably very small.

At end of the article are the tables of corrected multipliers which were constructed. Many of the activities which needed correction are not represented here, but they apparently appear infrequently in children's activities. If any of them should appear in subsequent records, the experimenter who analyzed the data would have to correct the multiplier as well as possible following the method used in this study. On the rating scale, the items which need corrected multipliers are marked with an asterisk.

THE SUBJECTS

The subjects of this study were thirty-two children, sixteen boys and sixteen girls, paired as nearly as possible according to chronological age. There were not enough children available to make it possible to consider mental ages and IQ's in making the pairings. The subjects ranged in chronological age from 24.0

months to 54.0 months with a mean of 39.9 months. The mental ages ranged from 22.3 months to 61.5 months with a mean of 46.9 months. No intelligence test was obtained on three pairs of children.

Cases were taken from four different preschools in order to have as unselected a group as possible. Seven pairs were taken from the Mills College preschool laboratory. The children were from American homes of above average social status. Six pairs were taken from the Institute of Child Welfare in Berkeley and represent professional families. Two pairs were Italian children, and one pair consisted of Russian twins, all of them from philanthropic preschools of the Golden Gate Kindergarten Association. These children came from homes of low economic status.

THE DATA

Diary records were taken with the aid of a stop watch, indicating each activity engaged in by the child and the number of seconds spent at the activity. The experimenter took the records of twelve children, and two graduate students who were trained to make the observations took records of the other four pairs. Taking the records accurately necessitated great familiarity with the list of activities and experience in making the diaries with the aid of the stop watch.

Since the records were made in order to investigate sex differences, time was equated. Both children of each pair were observed on two consecutive mornings at alternate times -- either during the first part of the morning or during the latter part. That is, if boy A was observed during the first part of the morning on one day and girl A during the latter part, on the following day girl A would be observed first and boy A later.

Each observation was from fifty minutes to one and one-half hours in length depending upon how much it was interrupted by adult suggestion. All items which were affected by adult suggestion were eliminated from the record.

SPECIAL PROBLEMS IN CLASSIFYING DATA

The diary records were classified according to the rating scale as already described. There were a few items in the data which were not found in the rating scale. Most of these could be classified approximately. The items in the scale used as the classification were so similar to those in the diary that it is doubtful that inaccuracy resulted. Following are a few examples of the activities which were only approximately classified.

Item in Record	Classified
Climbing along bar	Going across on jungle gym
Climbing onto stump and off	Climbing onto large packing box
Climbing onto back of bench and off	Climbing on and off of large chair or piano bench

Fifty-nine different activities, appearing 275 times and representing 3,092 seconds or 2 per cent of the data, were approximately classified.

If an item in the diary record could not be classified even approximately on the rating scale, it was discarded. Forty-two different items appearing 101 times in the diary and representing 1,491 seconds or .9 per cent of the total time were discarded because they could not be classified.

Forty minutes were retained for each of the two records on each child except in the case of girl D, whose first hour of observation was 5 minutes, 47 seconds short.

VIGOROUSNESS OF CHILDREN

A final vigorousness score was obtained for each child. These scores ranged from 7.32 to 20.77, the mean being 13.28 with a standard deviation of 3.07. This shows a large variability in the vigorousness of the children.

RELIABILITY OF THE DATA

In order to determine whether two forty-minute observations are enough to give reliable scores, correlations were found between vigorousness scores of the two forty-minute periods of observation. Correlations between the first hour and the second hour observations were .35 for the boys and .18 for the girls. Correlations between Observation I and Observation II were .38 for the boys and .15 for the girls. These are very low correlations and show that there is not only great variability among the members of the group but that each child varies from day to day in the vigorousness of his activities.

These very low correlations suggested that two forty-minute periods are not a large enough sampling of time to obtain reliable results. On the other hand, there was a possibility that the large variation from one day to the next might be much influenced by a child participating in one activity for a long period of time. For this reason correlations were found between the odd and the even five-minute periods throughout the entire eighty minutes of the observations.

For the boys this correlation was .79 ± .09 and for the girls it was .87 ± .06. For both together it was .85 ± .03. When the correlations were corrected by the Spearman-Brown formula, they became .88 for the boys, .93 for the girls, and .92 for both. These are high correlations and indicate that the mean vigorousness scores obtained in this study are reliable.

The results of these correlations also show that forty-minute samples are too long and are likely to be influenced unduly by the possibility of a child staying at one activity during much of the observation period. The method of repeated short samples in taking the data would be more reliable. The correlations shown above indicated that high reliability can be obtained by sixteen five-minute observations even though they are made on two consecutive days, with each half of the observations being consecutive.

SUMMARY AND CONCLUSIONS

1. Using the method of expert judges, a rating scale of the vigorousness of

the activities of preschool children was constructed. The scale consisted of activities ranging in vigorousness level from 1 (not at all vigorous) to 48 (very vigorous).

2. The judges agreed rather highly in rating the activities according to vigorousness. The correlation between the mean ratings of half of the judges against those of the other half was .90.

3. The reliability of the rating scale is high. The correlation between the vigorousness scores obtained from thirty-four consecutive five-minute observations made by two recorders independently though simultaneously was .98.

4. The data consist of detailed diary records taken with the aid of a stop watch. Two forty-minute observations were made on thirty-two preschool children, sixteen boys and sixteen girls paired as to chronological age. When these observations were classified according to the rating scale, it was found that the mean vigorousness score was 13.28.

5. Two forty-minute observations give reliable vigorousness scores as measured by the correlation between odd and even five-minute periods. The correlation is .92 ± .026 when corrected by the Spearman-Brown formula.

6. A study of sex differences in vigorousness of activity of preschool children based upon the use of this rating scale will be reported later.

It seems that this scale might be of value in further research. It would be interesting to determine the relationships between vigorousness scores and such factors as body build, ascendancy or submission, motor control, or length of school attendance.

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN

Item	Activity	Vigorousness
	Activities on the Jungle Gym	
1*	Climbing up or down one step of the jungle gym	22
2*	Climbing up or down two or more steps of the jungle gym	29
3	Going across on jungle gym	28
4	Going diagonally across on jungle gym	29
5	Going diagonally across and up or down on jungle gym	31
6	Standing up on the top bars of the jungle gym, not taking hold of bar for support	18
7	Standing on bar of jungle gym, taking hold	12
8	Standing on bar of jungle gym, taking hold of bar on same level	11
9	Balancing on stomach on bar of jungle gym	20
10	Sitting on bar of jungle gym, taking hold of bar or bars above	11
11	Sitting on bar of jungle gym, taking hold of bar or bars on same level	9
12	Crawling on hands and feet on jungle gym	19
13	Hanging by both hands on bar of jungle gym or other bar	27
14	Hanging by both hands on bar swinging self	32
15	Hanging by both hands on bar being swung by somebody else	28
16	Pulling self up when hanging by arms as in chinning	36
17	Hanging by one hand on bar	27
18	Hanging by one hand on bar swinging self	32
19	Hanging by one hand on bar being swung by somebody else	29
20*	Turning somersault over low bar	32
21	Walking around underneath jungle gym, stepping over low bar	26
	Activities on Slide	
22*	Slowly climbing up one or two steps of the slide one step at a time	22
23*	Rapidly climbing up one or two steps of the slide one step at a time	28
24*	Slowly climbing to top of slide one step at a time	26
25*	Rapidly climbing to top of slide one step at a time	34
26*	Getting to a second step of slide two steps at a time	25
27*	Getting down from the second step of the slide, two steps at a time	24
28*	Slowly climbing to top of slide two steps at a time	27
29*	Rapidly climbing to top of slide two steps at a time	34
30*	Slowly climbing up one or two steps of the slide one step at a time carrying a light object, as a ball, doll, or block	26
31*	Rapidly climbing up one or two steps of the slide one step at a time carrying a light object, as a ball, doll, or block	30
32*	Slowly climbing to top of slide one step at a time carrying a light object, as a ball, doll, or block	27
33*	Rapidly climbing to top of slide one step at a time, carrying a light object, as a ball, doll, or block	31
34*	Getting to second step of slide two steps at a time carrying a light object as a ball, doll, or block	30
35	Getting down from the second step of the slide two steps at a time, carrying a light object as a ball, doll, or block	26
36*	Slowly climbing to the top of the slide two steps at a time, carrying a light object as a ball, doll, or block	31
37*	Rapidly climbing to the top of slide two steps at a time carrying a light object as a ball, doll, or block	36
38*	Slowly climbing down one or two steps of the slide one step at a time	22
39*	Rapidly climbing down one or two steps of the slide one step at a time	29
40*	Slowly climbing down from top of slide one step at a time	27
41*	Rapidly climbing down from top of slide one step at a time	31
42*	Slowly climbing down from top of slide two steps at a time	26

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
43*	Rapidly climbing down from top of slide two steps at a time	29
44*	Slowly climbing down one or two steps of slide one step at a time, carrying a light object as a ball, doll, or block	26
45*	Rapidly climbing down one or two steps of slide one step at a time, carrying a light object as a ball,doll,or block	30
46*	Slowly climbing down from top of slide one step at a time carrying a light object, as a ball, doll, or block	26
47*	Rapidly climbing down from top of slide one step at a time, carrying a light object as a ball, doll, or block	31
48*	Slowly climbing down from top of slide one step at a time, carrying a light object as a ball, doll, or block	28
49*	Rapidly climbing down from top of slide two steps at a time carrying a light object as a ball, doll, or block	33
50*	Getting to a sitting position on top of slide and sliding down frontward	23
51*	Getting to a sitting position on top of slide and sliding down backward	20
52*	Getting on stomach and sliding down slide head first	21
53*	Getting on stomach and sliding down slide feet first	21
54*	Getting on back and sliding down slide head first	23
55*	Getting on back and sliding down slide feet first	21
56	Getting to a sitting position on top of slide and sliding down frontward, holding self back with hands and feet	24
57	Getting to a sitting position on top of slide and sliding down backward, holding self back with hands and feet	24
58	Getting on stomach and sliding down slide head first, holding back with hands and feet	24
59	Getting on stomach and sliding down slide feet first, holding self back with hands and feet	24
60	Getting on back and sliding down slide head first, holding self back with hands and feet	25
61	Getting on back and sliding down slide feet first, holding self back with hands and feet	25
62*	Slowly climbing part way up the chute of the slide when it is slippery	24
63*	Rapidly climbing part way up the chute of the slide when it is slippery	36
64*	Slowly climbing all of the way up the chute of the slide when it is slippery	35
65*	Rapidly climbing all of the way up the chute of the slide when it is slippery	41
66	Slowly climbing part way down the chute of the slide when it is slippery	37
67	Rapidly climbing part way down the chute of the slide when it is slippery	35
68	Slowly climbing all of the way down the chute of the slide when it is slippery	36
69	Rapidly climbing all of the way down the chute of the slide when it is slippery	37
70*	Slowly climbing part way up the chute of the slide when it is not slippery or when child has rubbers on	30
71*	Rapidly climbing part way up the chute of the slide when it is not slippery or when child has rubbers on	36
72*	Slowly climbing all the way up the chute of the slide when it is not slippery or when child has rubbers on	31
73*	Rapidly climbing all the way up the chute of the slide when it is not slippery or when child has rubbers on	35

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - *Continued*

Item	Activity	Vigorousness
74	Slowly climbing part way down the chute of the slide when it is not slippery or when child has rubbers on	29
75*	Rapidly climbing part way down the chute of the slide when it is not slippery or when child has rubbers on	32
76*	Slowly climbing all the way down the chute of the slide when it is not slippery or when child has rubbers on	31
77*	Rapidly climbing all the way down the chute of the slide when it is not slippery or when child has rubbers on	35
	Activities using the Swings	
78	Sitting, swinging self slightly by pushing with feet	14
79	Sitting, swinging self high by pushing with feet	26
80	Sitting, swinging self slightly using arms and back muscle rather than pushing with feet	19
81	Sitting, swinging self slightly using arm and back muscles and also pushing with feet	21
82	Sitting, swinging self high using arms and back muscles rather than pushing self with feet	28
83	Sitting, swinging self high using arm and back muscles and also pushing with feet	31
84	Standing, swinging self slightly	21
85	Standing, swinging self high	30
86	Swinging empty swing by taking hold of it and walking back and forth	20
87	Swinging empty swing by pushing it	17
88	Swinging child by taking hold of swing and walking back and forth	31
89	Swinging child by pushing swing	28
90	Sitting in swing, turning around and around to twist rope	16
91	Sitting in swing, balancing as twisted rope untwists	11
92	Turning empty swing around and around, twisting the rope	16
93	Turning swing with child in it around and around twisting the rope	25
	Activities Using Incline Board	
94*	Slowly walking up incline board	32
95*	Rapidly walking up incline board	33
96*	Running up incline board	39
97*	Slowly walking up incline board, carrying light object as ball, doll, or block	28
98*	Rapidly walking up incline board, carrying light object as ball, doll, or block	35
99*	Running up incline board, carrying small object as ball, doll, or block	39
100*	Slowly walking up incline board, carrying two or more small objects as ball, doll, or block	29
101*	Rapidly walking up incline board, carrying two or more small objects as ball, doll, or block	35
102*	Running up incline board, carrying two or more small objects as ball, doll, or block	41
103*	Slowly walking up incline board, carrying rather a heavy object as large block	31
104*	Rapidly walking up incline board, carrying rather a heavy object as large block	36
105*	Running walking up incline board, carrying rather a heavy object as large block	42
106*	Slowly walking up incline board, carrying a heavy object as chair, table, or ironing board	34
107*	Rapidly walking up incline board, carrying a heavy object as chair, table, or ironing board	39
108*	Running up incline board, carrying a heavy object as chair, table, or ironing board	48
109*	Slowly walking down incline board	19
110*	Rapidly walking down incline board	27

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
111*	Running down incline board	33
112*	Slowly walking down incline board, carrying a light object as ball, doll, or block	23
113*	Rapidly walking down incline board, carrying a light object as ball, doll, or block	28
114*	Running down incline board, carrying a light object as ball, doll, or block	32
115*	Slowly walking down incline board, carrying two or more light objects as ball, doll, or block	24
116*	Rapidly walking down incline board, carrying two or more small objects, as ball, doll, or block	28
117*	Running down incline board, carrying two or more small objects, as ball, doll, or block	34
118*	Slowly walking down incline board, carrying a rather heavy object, as large block	26
119*	Rapidly walking down incline board, carrying a rather heavy object as large block	32
120*	Running down incline board, carrying a rather heavy object as large block	35
121*	Slowly walking down incline board, carrying a heavy object as chair, table, or ironing board	28
122*	Rapidly walking down incline board, carrying a heavy object as chair, table, or ironing board	34
123*	Running down incline board, carrying a heavy object as chair, table, or ironing board	36
124*	Sitting on incline board and sliding down frontward, helping self along with hands and feet	23
125*	Sitting on incline board and sliding down backward, helping self along with hands and feet	23
126*	Sliding down incline board on stomach head first, helping self along with hands and feet	25
127*	Sliding down incline board on stomach feet first, helping self along with hands and feet	24
128*	Sliding down incline board on back head first, helping self along with hands and feet	23
129*	Sliding down incline board on back feet first, helping self along with hands and feet	23
130	Rolling down incline board	22
131*	Standing, sliding down incline board	27
	Activities on the Seesaw	
132	Sitting on seesaw inactive	3
133	Sitting on seesaw making it go mildly	11
134	Sitting on seesaw making it go vigorously	23
135*	Climbing up seesaw	30
136	Pushing seesaw up and down when not on it, when other children are on it	29
137	Pushing empty seesaw up and down	18
138	Standing, balancing on middle of seesaw when it is moving slightly	17
139	Standing, balancing on middle of seesaw when it is moving vigorously	23
140*	Climbing onto middle of seesaw	25
141*	Climbing onto seesaw when it is low	22
142*	Climbing onto seesaw when it is high	32
	Activities on Climbing Rope	
143	Hanging on climbing rope with both hands	26
144	Hanging on climbing rope with one hand	26
145	Swinging self on climbing rope by using feet to push	33
146	Hanging on climbing rope being swung by somebody else	22
147	Taking hold of climbing rope and walking about	18
148	Taking hold of climbing rope and running about	32
	Activities on Bar**	
149*	Turning somersaults frontward over bar	37
150*	Getting on top of bar and sitting	23

* - Indicates items which take corrected multipliers
** - See also items included under jungle gym

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
151	Getting on bar balancing on stomach	25
	Activities in Sand Box* **	
152	Sitting in outdoor sand box playing quietly	5
153	Sitting in outdoor sand box playing rather vigorously, as digging and pushing sand about strenuously	12
154	Walking about in outdoor sand box, stooping picking up things, etc.	17
155	Standing by indoor sand box, playing quietly	10
156	Moving quickly around or otherwise playing vigorously at indoor sand box	19
157	Standing on edge of sand box	10
158	Walking on edge of sand box	21
159*	Climbing in or out of sand box	17
160	Squatting in sand box playing quietly	7
161	Squatting in sand box playing more vigorously as digging and pushing sand about strenuously	13
	Activities on Walking Board	
162	Balancing on walking board	15
163	Walking and balancing on walking board	20
	Activities on Kiddie Kar or Tricycle	
164	Sitting on tricycle or kiddie kar, inactive	3
165	Sitting on tricycle or kiddie kar, making it move back and forth slightly	8
166	Riding slowly on tricycle or kiddie kar on floor or pavement, using pedals	25
167	Riding rapidly on tricycle or kiddie kar on floor or pavement, using pedals	33
168	Riding slowly on tricycle or kiddie kar on hard ground, using pedals	27
169	Riding rapidly on tricycle or kiddie kar on hard ground, using pedals	32
170	Riding slowly on tricycle or kiddie kar on lawn, using pedals	29
171	Riding rapidly on tricycle or kiddie kar on lawn, using pedals	38
172	Riding slowly on tricycle or kiddie kar through bushes, using pedals	35
173	Riding rapidly on tricycle or kiddie kar through bushes, using pedals	40
174*	Riding slowly on tricycle or kiddie kar up incline board, using pedals	37
175*	Riding rapidly on tricycle or kiddie kar up incline board, using pedals	34
176*	Riding slowly on tricycle or kiddie kar down incline board, using pedals	29
177*	Riding rapidly on tricycle or kiddie kar down incline board, using pedals	33
178	Riding slowly on tricycle or kiddie kar on floor or pavement with other object attached, using pedals	30
179	Riding rapidly on tricycle or kiddie kar on floor or pavement with other object attached, using pedals	36
180	Riding slowly on tricycle or kiddie kar on hard ground with other object attached, using pedals	31
181	Riding rapidly on tricycle or kiddie kar on hard ground with other object attached, using pedals	36
182	Riding slowly on tricycle or kiddie kar on lawn with other object attached, using pedals	31
183	Riding rapidly on tricycle or kiddie kar on lawn with other objects attached, using pedals	38
184	Riding slowly on tricycle or kiddie kar through bushes with other objects attached, using pedals	37
185	Riding rapidly on tricycle or kiddie kar through bushes with other objects attached, using pedals	42
186*	Riding slowly on tricycle or kiddie kar up incline board with other object attached, using pedals	41

* - Indicates items which take corrected multipliers
*** - See also miscellaneous sitting activities

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
187*	Riding rapidly on tricycle or kiddie kar up incline board with other object attached, using pedals	46
188*	Riding slowly on tricycle or kiddie kar down incline board with other object attached, using pedals	32
189*	Riding rapidly on tricycle or kiddie kar down incline board with other object attached, using pedals	33
190	Riding slowly on tricycle or kiddie kar on floor or pavement, carrying object while riding, using pedals	31
191	Riding rapidly on tricycle or kiddie kar on floor or pavement, carrying object while riding, using pedals	35
192	Riding slowly on tricycle or kiddie kar on hard ground, carrying object while riding, using pedals	31
193	Riding rapidly on tricycle or kiddie kar on hard ground, carrying object while riding, using pedals	37
194	Riding slowly on tricycle or kiddie kar on lawn, carrying object while riding, using pedals	33
195	Riding rapidly on tricycle or kiddie kar on lawn, carrying object while riding, using pedals	38
196	Riding slowly on tricycle or kiddie kar through bushes, carrying object while riding, using pedals	36
197	Riding rapidly on tricycle or kiddie kar through bushes, carrying object while riding, using pedals	42
198*	Riding slqwly on tricycle or kiddie kar up incline board, carrying object while riding, using pedals	39
199*	Riding rapidly on tricycle or kiddie kar up incline board, carrying object while riding, using pedals	46
200*	Riding slowly on tricycle or kiddie kar down incline board, carrying object while riding, using pedals	30
201*	Riding rapidly on tricycle or kiddie kar down incline board, carrying object while riding, using pedals	33
202	Riding slowly on tricycle or kiddie kar on floor or pavement, not using pedals but pushing with feet	26
203	Riding rapidly on tricycle or kiddie kar on floor or pavement, not using pedals but pushing with feet	30
204	Riding slowly on tricycle or kiddie kar on hard ground, not using pedals but pushing with feet	26
205	Riding rapidly on tricycle or kiddie kar on hard ground, not using pedals but pushing with feet	34
206	Riding slowly on tricycle or kiddie kar on lawn, not using pedals but pushing with feet	30
207	Riding rapidly on tricycle or kiddie kar on lawn, not using pedals but pushing with feet	37
208	Riding slowly on tricycle or kiddie kar through bushes, not using pedals but pushing with feet	33
209	Riding rapidly on tricycle or kiddie kar through bushes, not using pedals but pushing with feet	39
210*	Riding slowly on tricycle or kiddie kar up incline board, not using pedals but pushing with feet	37
211*	Riding rapidly on tricycle or kiddie kar up incline board, not using pedals but pushing with feet	43
212*	Riding slowly on tricycle or kiddie kar down incline board, not using pedals but pushing with feet	27
213*	Riding rapidly on tricycle or kiddie kar down incline board, not using pedals but pushing with feet	31
214	Riding slowly on tricycle or kiddie kar on floor or pavement with other object attached, not using pedals but pushing with feet	29

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
215	Riding rapidly on tricycle or kiddie kar on floor or pavement with other object attached, not using pedals but pushing with feet	36
216	Riding slowly on tricycle or kiddie kar on hard ground with other object attached, not using pedals but pushing with feet	31
217	Riding rapidly on tricycle or kiddie kar on hard ground with other object attached, not using pedals but pushing with feet	38
218	Riding slowly on tricycle or kiddie kar on lawn with other object attached, not using pedals but pushing with feet	34
219	Riding rapidly on tricycle or kiddie kar on lawn with other object attached, not using pedals but pushing with feet	39
220	Riding slowly on tricycle or kiddie kar through bushes with other object attached, not using pedals but pushing with feet	34
221	Riding rapidly on tricycle or kiddie kar through bushes with other object attached, not using pedals but pushing with feet	38
222*	Riding slowly on tricycle or kiddie kar up incline board with other object attached, not using pedals but pushing with feet	39
223*	Riding rapidly on tricycle or kiddie kar up incline board with other object attached, not using pedals but pushing with feet	45
224*	Riding slowly on tricycle or kiddie kar down incline board with other object attached, not using pedals but pushing with feet	27
225*	Riding rapidly on tricycle or kiddie kar down incline board with other object attached, not using pedals but pushing with feet	32
226	Riding slowly on tricycle or kiddie kar on floor or pavement, carrying object while riding, not using pedals but pushing with feet	27
227	Riding rapidly on tricycle or kiddie kar on floor or pavement, carrying object while riding, not using pedals but pushing with feet	35
228	Riding slowly on tricycle or kiddie kar on hard ground, carrying object while riding, not using pedals but pushing with feet	29
229	Riding rapidly on tricycle or kiddie kar on hard ground, carrying object while riding, not using pedals but pushing with feet	36
230	Riding slowly on tricycle or kiddie kar on lawn, carrying object while riding, not using pedals but pushing with feet	34
231	Riding rapidly on tricycle or kiddie kar on lawn, carrying object while riding, not using pedals but pushing with feet	37
232	Riding slowly on tricycle or kiddie kar through bushes, carrying object while riding, not using pedals but pushing with feet	36
233	Riding rapidly on tricycle or kiddie kar through bushes, carrying object while riding, not using pedals but pushing with feet	39
234*	Riding slowly on tricycle or kiddie kar up incline board, carrying object while riding, not using pedals but pushing with feet	40
235*	Riding rapidly on tricycle or kiddie kar up incline board, carrying object while riding, not using pedals but pushing with feet	44
236*	Riding slowly on tricycle or kiddie kar down incline board, carrying object while riding, not using pedals but pushing with feet	30

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
237*	Riding rapidly on tricycle or kiddie kar down incline board, carrying object while riding, not using pedals but pushing with feet	32
238	Slowly pushing or pulling about tricycle or kiddie kar on floor or pavement	25
239	Rapidly pushing or pulling about tricycle or kiddie kar on floor or pavement	31
240	Slowly pushing or pulling about tricycle or kiddie kar on hard ground	26
241	Rapidly pushing or pulling about tricycle or kiddie kar on hard ground	33
242	Slowly pushing or pulling about tricycle or kiddie kar on lawn	28
243	Rapidly pushing or pulling about tricycle or kiddie kar on lawn	34
244	Slowly pushing or pulling tricycle or kiddie kar through bushes	32
245	Rapidly pushing or pulling tricycle or kiddie kar through bushes	31
246	Slowly pushing or pulling about child on tricycle or kiddie kar on floor or pavement	33
247	Rapidly pushing or pulling about child on tricycle or kiddie kar on floor or pavement	38
248	Slowly pushing or pulling about child on tricycle or kiddie kar on hard ground	33
249	Rapidly pushing or pulling about child on tricycle or kiddie kar on hard ground	38
250	Slowly pushing or pulling about child on tricycle or kiddie kar on lawn	37
251	Rapidly pushing or pulling about child on tricycle or kiddie kar on lawn	41
252	Slowly pushing or pulling child on tricycle or kiddie kar through bushes	36
253	Rapidly pushing or pulling child on tricycle or kiddie kar through bushes	42
254*	Slowly pushing or pulling child on tricycle or kiddie kar up incline board	43
255*	Rapidly pushing or pulling child on tricycle or kiddie kar up incline board	47
256*	Slowly pushing or pulling child on tricycle or kiddie kar down incline board	35
257*	Rapidly pushing or pulling child on tricycle or kiddie kar down incline board	37
258	Standing on back bar of tricycle with one foot and slowly pushing self along with other foot	27
259	Standing on back bar of tricycle with one foot and rapidly pushing self along with other foot	28
260*	Slowly pushing or pulling tricycle or kiddie kar up incline board	37
261*	Rapidly pushing or pulling tricycle or kiddie kar up incline board	40
262*	Slowly pushing or pulling tricycle or kiddie kar down incline board	27
263*	Rapidly pushing or pulling tricycle or kiddie kar down incline board	34
264	Slowly pushing or pulling tricycle or kiddie kar about on floor or pavement with other object attached	28
265	Rapidly pushing or pulling tricycle or kiddie kar about on floor or pavement with other object attached	34
266	Slowly pushing or pulling tricycle or kiddie kar about on hard ground with other object attached	28
267	Rapidly pushing or pulling tricycle or kiddie kar about on hard ground with other object attached	34
268	Slowly pushing or pulling tricycle or kiddie kar about on lawn with other object attached	33
269	Rapidly pushing or pulling tricycle or kiddie kar about on lawn with other object attached	38
270	Slowly pushing or pulling tricycle or kiddie kar through bushes with other object attached	36
271	Rapidly pushing or pulling tricycle or kiddie kar through bushes with other object attached	41

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
272*	Slowly pushing or pulling tricycle or kiddie kar up incline board with other object attached	40
273*	Rapidly pushing or pulling tricycle or kiddie kar up incline board with other object attached	41
274*	Slowly pushing or pulling tricycle or kiddie kar down incline board with other object attached	26
275*	Rapidly pushing or pulling tricycle or kiddie kar down incline board with other object attached	33
	Activities with Wagon	
276	Making self go in wagon on floor or pavement not very vigorously	26
277	Making self go in wagon on hard ground not very vigorously	30
278	Making self go in wagon on lawn not very vigorously	32
279	Making self go in wagon through bushes not very vigorously	35
280*	Making self go in wagon up incline board not very vigorously	37
281*	Making self go in wagon down incline board not very vigorously	31
282	Making self go in wagon on floor or pavement vigorously	38
283	Making self go in wagon on hard ground vigorously	36
284	Making self go in wagon on lawn vigorously	38
285	Making self go in wagon through bushes vigorously	43
286*	Making self go in wagon up incline board vigorously	43
287*	Making self go in wagon down incline board vigorously	35
288	Walking while pushing or pulling empty wagon on floor or pavement	23
289	Walking while pushing or pulling empty wagon on hard ground	25
290	Walking while pushing or pulling empty wagon on lawn	25
291	Walking while pushing or pulling empty wagon through bushes	31
292*	Walking while pushing or pulling empty wagon up incline board	34
293*	Walking while pushing or pulling empty wagon down incline board	25
294	Walking while pushing or pulling loaded wagon on floor or pavement	28
295	Walking while pushing or pulling loaded wagon on hard ground	29
296	Walking while pushing or pulling loaded wagon on lawn	29
297	Walking while pushing or pulling loaded wagon through bushes	34
298*	Walking while pushing or pulling loaded wagon up incline board	37
299	Walking while pushing or pulling loaded wagon down incline board	30
300	Walking while pushing or pulling wagon with child in it on floor or pavement	32
301	Walking while pushing or pulling wagon with child in it on hard ground	33
302	Walking while pushing or pulling wagon with child in it on lawn	38
303	Walking while pushing or pulling wagon with child in it through bushes	38
304*	Walking while pushing or pulling wagon with child in it up incline board	42
305*	Walking while pushing or pulling wagon with child in it down incline board	31
306	Running while pushing or pulling empty wagon on floor or pavement	29
307	Running while pushing or pulling empty wagon on hard ground	30
308	Running while pushing or pulling empty wagon on lawn	33
309	Running while pushing or pulling empty wagon through bushes	37
310*	Running while pushing or pulling empty wagon up incline board	40
311	Running while pushing or pulling empty wagon down incline board	33
312	Running while pushing or pulling loaded wagon on floor or pavement	37

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
313	Running while pushing or pulling loaded wagon on hard ground	37
314	Running while pushing or pulling loaded wagon on lawn	39
315	Running while pushing or pulling loaded wagon through bushes	42
316*	Running while pushing or pulling loaded wagon up incline board	34
317*	Running while pushing or pulling loaded wagon down incline board	44
318	Running on floor or pavement while pushing or pulling wagon with child in it	37
319	Running on hard ground while pushing or pulling wagon with child in it	40
320	Running on lawn while pushing or pulling wagon with child in it	42
321	Running through bushes while pushing or pulling wagon with child in it	45
322*	Running up incline board while pushing or pulling wagon with child in it	46
323*	Running down incline board while pushing or pulling wagon with child in it	38
324*	Climbing in and out of wagon; getting on or off tricycle**	25
325	Loading up wagon or wheelbarrow with light object	20
326	Loading up wagon or wheelbarrow with heavy object	27
327	Pushing wagon back and forth while standing	15
328	Pushing wagon back and forth while sitting	10
	Activities with Wheelbarrow	
329	Walking while pushing or pulling empty wheelbarrow on floor or pavement	26
330	Walking while pushing or pulling empty wheelbarrow on hard ground	27
331	Walking while pushing or pulling empty wheelbarrow on lawn	28
332	Walking while pushing or pulling empty wheelbarrow through bushes	33
333*	Walking while pushing or pulling empty wheelbarrow up incline board	33
334	Walking while pushing or pulling empty wheelbarrow down incline board	27
335	Walking while pushing or pulling loaded wheelbarrow on floor or pavement	31
336	Walking while pushing or pulling loaded wheelbarrow on hard ground	33
337	Walking while pushing or pulling loaded wheelbarrow on lawn	34
338	Walking while pushing or pulling loaded wheelbarrow through bushes	37
339*	Walking while pushing or pulling loaded wheelbarrow up incline board	40
340*	Walking while pushing or pulling loaded wheelbarrow down incline board	30
341	Running while pushing or pulling empty wheelbarrow on floor or pavement	35
342	Running while pushing or pulling empty wheelbarrow on hard ground	36
343	Running while pushing or pulling empty wheelbarrow on lawn	36
344	Running while pushing or pulling empty wheelbarrow through bushes	41
345*	Running while pushing or pulling empty wheelbarrow up incline board	41
346*	Running while pushing or pulling empty wheelbarrow down incline board	34
347	Running while pushing or pulling loaded wheelbarrow on floor or pavement	38
348	Running while pushing or pulling loaded wheelbarrow on hard ground	40
349	Running while pushing or pulling loaded wheelbarrow on lawn	40
350	Running while pushing or pulling loaded wheelbarrow through bushes	44
351*	Running while pushing or pulling loaded wheelbarrow up incline board	48
352*	Running while pushing or pulling loaded wheelbarrow down incline board	38
353	Duplicate. See item 325	18
354	Duplicate. See item 326	26
355	Getting in and out of wheelbarrow	21
356	Pushing wheelbarrow back and forth while standing	14
357	Pushing wheelbarrow back and forth while sitting	10

* - Indicates items which take corrected multipliers
** - "Getting on or off tricycle" was added after the scale was completed.

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
	Activities with Doll Buggy	
358	Walking on floor or pavement pushing or pulling empty doll buggy	23
359	Walking on hard ground pushing or pulling empty doll buggy	25
360	Walking on lawn pushing or pulling empty doll buggy	27
361	Walking through bushes pushing or pulling empty doll buggy	28
362*	Walking up incline board pushing or pulling empty doll buggy	35
363*	Walking down incline board pushing or pulling empty doll buggy	26
364	Walking on floor or pavement pushing or pulling loaded doll buggy	29
365	Walking on hard ground pushing or pulling loaded doll buggy	29
366	Walking on lawn pushing or pulling loaded doll buggy	32
367	Walking through bushes pushing or pulling loaded doll buggy	37
368*	Walking up incline board pushing or pulling loaded doll buggy	41
369*	Walking down incline board pushing or pulling loaded doll buggy	32
370	Running on floor or pavement pushing or pulling empty doll buggy	35
371	Running on hard ground pushing or pulling empty doll buggy	36
372	Running on lawn pushing or pulling empty doll buggy	36
373	Running through bushes pushing or pulling empty doll buggy	38
374*	Running up incline board pushing or pulling empty doll buggy	43
375*	Running down incline board pushing or pulling empty doll buggy	35
376	Running on floor or pavement pushing or pulling loaded doll buggy	37
377	Running on hard ground pushing or pulling loaded doll buggy	38
378	Running on lawn pushing or pulling loaded doll buggy	38
379	Running through bushes pushing or pulling loaded doll buggy	43
380*	Running up incline board pushing or pulling loaded doll buggy	44
381*	Running down incline board pushing or pulling loaded doll buggy	39
382	Loading up doll buggy with light objects	19
383	Loading up doll buggy with heavy objects	24
384*	Getting in and out of doll buggy	21
385	Pushing doll buggy back and forth while standing	15
386	Pushing doll buggy back and forth while sitting	10
	Activities with Balls	
387	Sitting on floor, throwing small ball a short distance with one hand	9
388	Sitting on floor, throwing small ball as far as possible with one hand	10
389	Sitting on floor, throwing small ball a short distance with both hands	22
390	Sitting on floor, throwing small ball as far as possible with both hands	12
391	Sitting on chair, throwing small ball a short distance with one hand	10
392	Sitting on chair, throwing small ball as far as possible with one hand	13
393	Sitting on chair, throwing small ball a short distance with both hands	9
394	Sitting on chair, throwing small ball as far as possible with both hands	12
395	Standing up, throwing small ball a short distance with one hand	17
396	Standing, throwing small ball as far as possible with one hand	17
397	Standing up, throwing small ball a short distance with both hands	16
398	Standing up, throwing small ball as far as possible with both hands	18
399	Squatting, throwing small ball a short distance with one hand	11
400	Squatting, throwing small ball as far as possible with one hand	15
401	Squatting, throwing small ball a short distance with both hands	13

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
402	Squatting, throwing small ball as far as possible with both hands	16
403	Standing, bouncing small ball with one hand	14
404	Standing, bouncing small ball with both hands	16
405	Throwing small ball with one hand and running after it	33
406	Throwing small ball with two hands and running after it	33
407	Bouncing small ball with one hand and running after it	32
408	Bouncing small ball with two hands and running after it	32
409	Throwing small ball to somebody and trying to catch it when it is returned or throwing it against something and trying to catch it when it bounces back	22
410	Kicking small ball about	23
411	Kicking small ball about and running after it	29
412	Sitting on floor, throwing large ball a short distance with one hand	11
413	Sitting on floor, throwing large ball as far as possible with one hand	12
414	Sitting on floor, throwing large ball a short distance with both hands	11
415	Sitting on floor, throwing large ball as far as possible with both hands	14
416	Sitting on chair, throwing large ball a short distance with one hand	10
417	Sitting on chair, throwing large ball as far as possible with one hand	12
418	Sitting on chair, throwing large ball a short distance with both hands	12
419	Sitting on chair, throwing large ball as far as possible with both hands	13
420	Standing up, throwing large ball a short distance with one hand	16
421	Standing up, throwing large ball as far as possible with one hand	23
422	Standing up, throwing large ball a short distance with both hands	18
423	Standing up, throwing large ball as far as possible with both hands	21
424	Squatting, throwing large ball a short distance with one hand	11
425	Squatting, throwing large ball as far as possible with one hand	15
426	Squatting, throwing large ball a short distance with both hands	14
427	Squatting, throwing large ball as far as possible with both hands	20
428	Standing, bouncing large ball with one hand	15
429	Standing, bouncing large ball with both hands	15
430	Throwing large ball with one hand and running after it	33
431	Throwing large ball with two hands and running after it	34
432	Bouncing large ball with one hand and running after it	33
433	Bouncing large ball with two hands and running after it	34
434	Throwing large ball to somebody and trying to catch it when it is returned or throwing it against something and trying to catch it when it bounces back	23
435	Kicking large ball about	26
436	Kicking large ball about and running after it	31
437	Sitting on large ball	4
438	Sitting on large ball, bouncing up and down	13
439	Balancing on stomach on large ball	15
	Activities with Brooms, Rakes, Etc.	
440	Sweeping with broom by dragging it along floor or ground using one hand	17
441	Sweeping with broom by picking it up as adults do but using only one hand	20
442	Sweeping with broom by dragging it along floor or ground using two hands	20
443	Sweeping with broom by picking it up as adults do using two hands	21
444	Holding dust pan for other person to use	9
445	Using dust pan and broom or brush	19
446	Waving broom about in air	18
447	Using rake or hoe by dragging it around using one hand	17

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
448	Using rake or hoe by picking it up and putting it down as adults do but using only one hand	19
449	Using rake or hoe by dragging it around using two hands	17
450	Using rake or hoe by picking it up and putting it down as adults do but using two hands	20
451	Using garden shovel with one hand	19
452	Using garden shovel with both hands	23
453	Using trowel	11
	Activities with Blocks	
454	Sitting on floor or ground, playing with small blocks or other small objects rather inactively	6
455	Sitting on floor or ground, playing with small blocks or other small objects vigorously, as piling them up, etc.	11
456	Sitting at table, playing with small blocks or other small objects rather inactively	7
457	Sitting at table, playing with small blocks or other small objects vigorously, as piling them up, etc.	9
458	Standing at table, playing with small blocks or other small objects rather inactively	10
459	Standing at table, playing with small blocks or other small objects vigorously, as piling them up, etc.	13
460	Playing with small blocks on floor more actively, i.e., creeping arcund, kneeling, etc.	14
461	Standing, stooping over, walking about playing with small blocks; picking them up, piling them, etc.	18
462	Sitting on floor or ground, playing with large blocks or other large objects rather inactively	8
463	Sitting on floor or ground,playing with large blocks or other large objects vigorously, as piling them up, etc.	11
464	Sitting at table, playing with large blocks or other large objects rather inactively	8
465	Sitting at table, playing with large blocks or other large objects vigorously, as piling them up, etc.	10
466	Standing at table, playing with large blocks or other large objects rather inactively	10
467	Standing at table, playing with large blocks or other large objects vigorously, as piling them up, etc.	14
468	Playing with large blocks on floor rather actively, i.e., creeping around, kneeling, etc.	19
469	Standing, stooping over, walking about playing with large blocks; picking them up, piling them, etc.	20
470	Creeping, pushing small block or other small object	15
471	Creeping, pushing large block or other large object	17
472	Walking, stooping over pushing small block or other small object	21
473	Walking, stooping over pushing large block or other large object	24
	Activities with Horse	
474	Sitting astride horse, inactive	3
475	Sitting astride horse with legs out straight along top	9
476	Sitting astride horse with feet on horse's head	7
477	Sitting astride horse with feet on ground or base, using them to make horse go	15
478	Sitting astride horse with feet down but bouncing by using muscles in back	22
479	Sitting astride horse with feet along back of horse, bouncing by using muscles in back	23
480	Sitting astride horse with feet on horse's head, bouncing horse by using muscles in back	24

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
	Activities with Housekeeping Toys	
481	Washing clothes by rubbing them together	15
482	Washing clothes by rubbing them on washboard, using one hand	14
483	Washing clothes by rubbing them on washboard, using both hands	18
484	Wringing clothes	15
485	Shaking clothes	15
486	Hanging clothes up	15
487	Folding small garments	9
488	Folding large things	12
489	Putting things in and taking them out of bureau drawers	10
490	Dressing doll	8
491	Undressing doll	7
492	Making doll bed or arranging blankets in doll buggy	12
493	Sitting having tea party, pouring tea, etc.	6
494	Playing house quietly, i.e., sitting, walking about a little, playing dolls, etc.	8
495	Playing house rather actively, as making visits, playing doctor, barber, hospital, etc.	20
496	Vigorous activity as playing robbers, holding door shut to keep out others, chasing, etc.	38
497	Ironing	14
	Miscellaneous Activity: Sitting Down	
498	Sitting inactive	2
499	Sitting on floor swaying back and forth, as rocking doll, etc.	7
500	Sitting on floor, manipulating small objects -- not doing anything which requires precision, as playing with small animal, etc., or looking at book	5
501	Sitting on floor, participating in quiet activity which requires precision, as stringing beads, putting pegs in board, drawing, using clay, etc.	7
502	Sitting on floor, participating in rather vigorous activity, as pounding, etc.	15
503	Sitting in chair, swaying back and forth, as rocking doll, etc.	7
504	Sitting at table, manipulating small objects -- not doing anything which requires precision, as playing with small block, animal, etc., or looking at book	5
505	Sitting at table, participating in quiet activity which requires precision, i.e., stringing beads, putting pegs in board, drawing, using clay, etc.	10
506	Sitting at table, participating in rather vigorous activity, as mixing clay, etc.	10
507	Sitting, pounding not very vigorously with hammer or other heavy object	10
508	Sitting, pounding vigorously with hammer or other heavy object	15
509	Sitting, playing piano not very vigorously with one hand	6
510	Sitting, playing piano not very vigorously with both hands	7
511	Sitting, playing piano vigorously with one hand	12
512	Sitting, playing piano vigorously with both hands	13
513	Sitting in rocking chair rocking	7
514	Sitting using saw not very vigorously	9
515	Sitting using saw vigorously	14
	Miscellaneous Activity: Kneeling Down	
516	Kneeling on floor inactive	4
517	Kneeling on floor, swaying back and forth (as rocking doll, etc.)	8
518	Kneeling on floor, manipulating small objects -- not doing anything which requires precision, as playing with small block, animal, etc., or looking at book	8
519	Kneeling on floor, participating in quiet activity which requires precision, as stringing beads, putting pegs in board, drawing, using clay, etc.	9
520	Kneeling on floor, participating in rather vigorous activity, as moving heavy objects about, etc.	18
521	Kneeling on floor, pounding not very vigorously with hammer or other heavy object	12

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
522	Kneeling, pounding vigorously with hammer or other heavy object	15
523	Kneeling, using saw not very vigorously	11
524	Kneeling, using saw vigorously	17
525	Kneeling on chair or bench at table, playing with small blocks or other small objects rather inactively	8
526	Kneeling on chair or bench at table, playing with small blocks or other small objects vigorously, as piling them up, etc.	12
527	Kneeling on chair or bench at table, playing vigorously with large blocks or other large objects	13
	Miscellaneous Activity: Squatting	
528	Squatting on floor, inactive	5
529	Squatting on floor, swaying back and forth (as rocking doll, etc.)	8
530	Squatting on floor, manipulating small objects -- not doing anything which requires precision, as playing with small block, animal, etc., or looking at book	8
531	Squatting on floor, participating in quiet activity which requires precision, i.e., stringing beads, putting pegs in board, drawing, using clay, etc.	9
532	Squatting on floor, participating in rather vigorous activity, as moving about heavy objects	15
533	Squatting, pounding not very vigorously with hammer or other heavy object	11
534	Squatting, pounding vigorously with hammer or other heavy object	17
535	Squatting, using saw not very vigorously	11
536	Squatting, using saw vigorously	17
	Miscellaneous Activity: Standing	
537	Standing inactive	5
538	Standing manipulating small objects -- doing something which does not require precision, i.e., playing with small block or animal or looking at book	10
539	Standing, participating in activity which requires precision, i.e., putting pegs in board, stringing beads, using crayon, clay, etc.	14
540	Standing, pounding not very vigorously with hammer or other heavy object	16
541	Standing, pounding vigorously with hammer or other heavy object	22
542	Standing stooping over, manipulating small objects on floor -- doing something which does not require precision, i.e., playing with small blocks, animal or looking at book	13
543	Standing stooping over, playing with things on floor which require precision, as putting pegs in board, etc.	18
544	Standing stooping over, playing vigorously with things on floor	18
545	Standing at easel, painting or drawing	9
546	Standing, mixing clay not very vigorously	10
547	Standing, mixing clay vigorously	17
548	Duplicate. See item 540	13
549	Duplicate. See item 541	18
550	Standing, using saw not vigorously	13
551	Standing, using saw vigorously	19
552	Standing, using vise not vigorously	12
553	Standing, using vise vigorously	17
554	Standing, playing piano with one hand not very vigorously	11
555	Standing, playing piano with both hands not very vigorously	11
556	Standing, playing piano with one hand vigorously	14
557	Standing, playing piano with both hands vigorously	15
558	Standing, waving arms about not vigorously	11
559	Standing, waving arms about vigorously	18
	Miscellaneous Activity: Running	
560	Running	33
561	Running, carrying light object as ball, doll, or block	35

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
562	Running, carrying two or more light objects as ball, doll, or block	37
563	Running, carrying rather heavy object, as large block	38
564	Running, carrying heavy object, as chair, table, or ironing board	40
565	Running, pushing or pulling small object, as animal on wheels, etc.	37
566	Running, carrying small object and pushing or pulling small object, as animal on wheels	38
567	Running, carrying rather heavy object and pushing or pulling small object, as animal on wheels	39
	Miscellaneous Activity: Walking	
568	Walking	18
569	Walking, carrying light object as ball, doll, or block	20
570	Walking, carrying two or more light objects as ball, doll, or block	21
571	Walking, carrying rather heavy object, as large block	25
572	Walking, carrying heavy object, as chair, table or ironing board	28
573	Walking, pushing or pulling small object, as animal on wheels	25
574	Walking, carrying small object and pushing or pulling small object, as animal on wheels	20
575	Walking, carrying rather heavy object and pushing or pulling small object, as animal on wheels	27
	Miscellaneous Activity: Climbing	
576*	Walking up stairs one step at a time	23
577*	Walking up stairs one step at a time, carrying light object, as ball, doll, or block	26
578*	Walking up stairs one step at a time, carrying two or more light objects, as ball, doll, or block	28
579*	Walking up stairs one step at a time, carrying rather heavy object, as large block	29
580*	Walking up stairs one step at a time, carrying heavy object, as chair, table or ironing board	31
581*	Walking up stairs one step at a time, pushing or pulling small object, as animal on wheels	27
582*	Walking up stairs one step at a time, pushing or pulling small object, as animal on wheels, and carrying light object, as ball, doll, or block	28
583*	Walking down stairs one step at a time	21
584*	Walking down stairs one step at a time, carrying light object, as ball, doll, or block	23
585*	Walking down stairs one step at a time, carrying two or more light objects, as ball, doll, or block	24
586*	Walking down stairs one step at a time, carrying rather heavy object, as large block	27
587*	Walking down stairs one step at a time, carrying heavy objects, as chair, table, or ironing board	31
588*	Walking down stairs one step at a time, pushing or pulling small object, as animal on wheels	27
589*	Walking down stairs one step at a time, pushing or pulling small object, as animal on wheels, and carrying a light object, as ball, doll, or block	28
590*	Walking up stairs two steps at a time	30
591*	Walking up stairs two steps at a time, carrying light object, as ball, doll, or block	34
592*	Walking up stairs two steps at a time, carrying rather heavy object, as large block	34
593*	Walking up stairs two steps at a time, carrying two or more light objects, as ball, doll, or block	32
594*	Walking up stairs two steps at a time, carrying heavy object, as chair, table, or ironing board	35
595*	Walking up stairs two steps at a time, pushing or pulling small object, as animal on wheels	34

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
596*	Walking up stairs two steps at a time, pushing or pulling small object, as animal on wheels, and carrying light object, as ball, doll, or block	33
597*	Walking down stairs two steps at a time	29
598*	Walking down stairs two steps at a time, carrying light object, as ball, doll, or block	31
599*	Walking down stairs two steps at a time, carrying rather heavy object, as large block	32
600*	Walking down stairs two steps at a time, carrying heavy object, as chair, table, or ironing board	35
601*	Walking down stairs two steps at a time, pushing or pulling small object, as animal on wheels, etc.	32
602*	Walking down stairs two steps at a time, pushing or pulling small object, as animal on wheels, and carrying light object, as ball, doll, or block	32
603*	Creeping upstairs on hands and knees frontward	22
604*	Creeping upstairs on hands and knees backward	21
605*	Creeping down stairs on hands and knees frontward	22
606*	Creeping down stairs on hands and knees backward	18
607*	Climbing on and off sawhorse	30
608*	Climbing into and out of large packing box	28
609*	Climbing on and off large packing box	29
610*	Climbing on and off fence	31
611*	Climbing up and down side of porch	29
612*	Climbing on and off window sill	29
613*	Climbing on and off outdoor cupboard	28
614*	Climbing on and off large chair or piano bench	23
615*	Climbing up one step of ladder	23
616*	Climbing up one step of ladder, carrying light object, as ball, doll, or block	26
617*	Climbing up one step of ladder, carrying rather heavy object, as large block	30
618*	Climbing up more than one step of ladder one step at a time	29
619*	Climbing up more than one step of ladder one step at a time, carrying light object, as ball, doll, or block	31
620*	Climbing up more than one step of ladder one step at a time, carrying rather heavy object, as large block	32
621*	Climbing up more than one step of ladder two steps at a time	31
622*	Climbing up more than one step of ladder two steps at a time carrying light object, as ball, doll, or block	35
623*	Climbing up more than one step of ladder two steps at a time, carrying rather heavy object, as large block	37
	Other Miscellaneous Activities	
624	Skipping with one foot not waving arms	32
625	Skipping with both feet not waving arms	36
626	Skipping with one foot waving arms	33
627	Skipping with both feet waving arms	37
628	Whirling around and around, not waving arms	33
629	Whirling around and around, waving arms	39
630	Galloping	38
631	Walking on all fours	22
632	Creeping on hands and knees	23
633	Tumbling about	30
634	Rolling on ground or floor	25
635*	Turning somersaults	36
636	Jumping off things, holding on to something	29
637	Jumping off things, not holding on	28
638	Jumping up and down, taking hold of something	32
639	Jumping up and down, not taking hold of something	34
640	Jumping for distance	39
641	Running and jumping	39
642	Hopping	37
643	Throwing miscellaneous objects	19
644	Kicking miscellaneous objects	25
645	Pummelling or wrestling some one mildly	31
646	Pummelling or wrestling some one vigorously	38

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Concluded

Item	Activity	Vigorousness
647	Lying inactively on floor or bed	1
648	Lying down, playing quietly, as playing with doll, pulling covers over self, etc.	4
649	Lying down, kicking not very vigorously	10
650	Lying down, kicking vigorously	17
651	Lying down, using arms vigorously	11

CORRECTED MULTIPLIERS

ACTIVITIES WHOSE MULTIPLIERS WERE CORRECTED

Activities With Plenty of Data

Time, Seconds	Corrected Multiplier
Item 2	
Up	
35	7.0
34	7.2
33	7.3
32	7.3
31	7.3
30	7.4
29	7.4
28	7.4
27	7.4
26	7.5
25	7.5
24	7.5
23	8.0
22	8.0
21	8.0
20	9.0
19	9.0
18	9.5
17	9.5
16	10.0
15	10.5
14	11.0
13	11.5
12*	12.0*
11	12.5
10	13.0
9	13.5
8	14.0
7	15.0
6	16.0
5	17.0
4	18.0
3	19.0
Total cases	17
Down	
11	5.5
10	6.0
9	7.0
8*	8.0*
7	9.0
6	10.0

Time, Seconds	Corrected Multiplier
5	11.0
4	12.0
3	13.0
Total cases	16
Vigorousness	29
Item 24	
Slowly	
45	4.9
28	5.0
27	5.0
26	5.0
25	5.0
24	5.0
23	5.1
22	5.1
21	5.1
20	5.1
19	5.2
18	5.2
17	5.2
16	5.3
15	5.3
14	5.4
13	5.4
12	5.5
11	5.6
10	5.8
9	6.0
8	6.5
7*	7.0*
Vigorousness	26
Item 25	
Rapidly	
6	6.0
5	6.5
4	7.0
3	8.0

Time, Seconds	Corrected Multiplier
Vigorousness	34
Total cases	89
Item 32	
Slowly	
14	8.2
13	8.5
12	9.0
11	9.5
10*	10.0*
Vigorousness	27
Item 33	
Rapidly	
9	10.0
8	10.0
7	11.0
Vigorousness	31
Total cases	7
Item 64	
Slowly	
37	7.0
36	7.2
35	7.2
34	7.4
33	7.6
32	7.8
31	8.0
30	8.0
29	8.5
28	9.0
27	9.5
26	10.0
25	10.5
24	11.0
23	11.5
22	12.0

Time, Seconds	Corrected Multiplier
21	13.0
20	14.0
19	16.0
18*	18.0*
Vigorousness	35
Item 65	
Rapidly	
17	16.0
16	17.0
15	18.0
14	19.0
13	20.0
12	21.0
11	22.0
10	23.0
9	24.0
8	25.0
7	26.0
6	27.0
5	28.0
Vigorousness	41
Total cases	23
Item 94	
Slowly	
14	2.4
13	2.6
12	2.8
11	3.0
10	3.5
9	4.0
8	4.5
7	5.0
6*	6.0*
Vigorousness	32

* - Median.

CORRECTED MULTIPLIERS - Continued

ACTIVITIES WHOSE MULTIPLIERS WERE CORRECTED

Activities with Plenty of Data

Time, Seconds	Corrected Multiplier
Item 95	
Rapidly	
5	6.0
4	7.0
Vigorousness	33
Total cases	36
Item 159	
11	2.1
10	2.1
9	2.1
8	2.2
7	2.2
6	2.3
5	2.4
4	2.5
3*	3.0*
2	3.5
1	4.0
Vigorousness	17
Total cases	40
Item 324	
19	1.5
18	1.5
17	1.5
16	1.5
15	1.5
14	1.6
13	1.6
12	1.6
11	1.6
10	1.7
9	1.7
8	1.7
7	1.8
6	1.9
5	2.0
4	2.5
3*	3.0*
2	3.5
1	4.0
Vigorousness	25
Total cases	170
Item 576	
17	2.4
16	2.4
15	2.4
14	2.4
13	2.5
12	2.5
11	2.5
10	2.6
9	2.6
8	2.7
7	2.8
6	3.0
5	3.5
4*	4.0*
3	4.5
2	5.0
Vigorousness	23
Total cases	96
Item 579	
17	5.0
16	5.1
15	5.1
14	5.2
13	5.2
12	5.3
11	5.3
10	5.4
9	5.5
8	6.0
7*	7.0*
6	8.0
5	9.0
4	10.0
Vigorousness	29
Total cases	17
Item 608	
29	5.0
28	5.0
27	5.0
26	5.0
25	5.1
24	5.1
23	5.1
22	5.1
21	5.2
20	5.2
19	5.2
18	5.3
17	5.3
16	5.3
15	5.3
14	5.4
13	5.4
12	5.4
11	5.5
10	5.6
9	5.8
8	6.0
7*	7.0*
6	7.5
5	8.0
4	9.0
3	10.0
2	12.0
Vigorousness	28
Total cases	60
Item 609	
On	
18	2.8
17	2.8
16	2.9
15	2.9
14	3.0
13	3.0
12	3.1
11	3.1
10	3.2
9	3.3
8	3.4
7	3.5
6	4.0
5*	5.0*
4	5.5
3	6.0
2	7.0
1	9.0
Total cases	37
Off	
12	1.5
11	1.5
10	1.5
9	1.6
8	1.6
7	1.7
6	1.8
5	1.9
4	2.0
3*	3.0*
2	4.0
1	5.0
Total cases	25
Vigorousness	29
Item 612	
14	3.0
13	3.0
12	3.5
11	4.0
10	5.0
9	5.5
8	6.0
7*	6.0*
6	7.0
5	8.0
4	9.0
3	10.0
2	11.0
Vigorousness	29
Total cases	12
Item 614	
On	
10	2.5
9	3.0
8	3.0
7	3.5
6	4.0
5*	5.0*
4	6.0
3	7.0
2	8.0
Total cases	25
Off	
15	.5
14	.5
13	.6
12	.6
11	.7
10	.8
9	.9
8	1.0
7	1.2
6	1.3
5	1.5
4	1.5
3*	3.0*
2	4.0
1	5.0
Total cases	21
Vigorousness	23

* - Median

CORRECTED MULTIPLIERS - Continued

ACTIVITIES WHOSE MULTIPLIERS WERE CORRECTED

Activities for Which There is Little Data

Time, Seconds	Corrected Multiplier
Item 1	
Up	
17	4.0
16	4.0
10	5.5
9	6.0
3	8.0
1	10.0
Total cases	9
Down	
1	4.1
Total cases	4
Vigorousness	22
Items 28 and 29**	
9	7
7	9
Total cases	2
Items 62 and 63♯	
20	45
12	6
6	6
Total cases	3
Item 96	
3	2
2	3
Vigorousness	39
Total cases	4
Item 292	
49	7.5
47	7.5
33	8.0
30	8.0
20	8.5
17	9.0
11	10.0
10	11.0
Vigorousness	34
Total cases	9
Item 362	
12	8
7	6
Vigorousness	35
Total cases	2
Item 368	
9	10
Vigorousness	41
Total cases	1
Item 384	
9	9
Vigorousness	21
Total cases	1
Item 577	
11	4.2
8	4.5
7	5.0
6*	6.0*
5	7.0
4	8.0
3	9.0
Vigorousness	26
Total cases	7
Item 580	
5	5
Vigorousness	31
Total cases	2
Item 603	
22	3
9	9
6	10
Vigorousness	22
Total cases	3
Item 607	
10	3
9	3
8	4
6	6
5	7
4	8
Vigorousness	30
Total cases	6
Item 610	
38	13.0
24	14.0
18	14.5
16	16.0
14	18.0
5	22.0
Vigorousness	31
Total cases	8
Item 611	
Both Up and Down	
32	7
31	8
26	9
25	10
15	15
11	19
Just Climbing Up	
18	6
7	8
6	9
Vigorousness	29
Total cases	10
Item 618	
16	8
9	10
Vigorousness	29
Total cases	2

* - Median
** - Vigorousness Score: Slowly, 27; Rapidly, 34
♯ - Vigorousness Score: Slowly, 24; Rapidly, 36

CORRECTED MULTIPLIERS - Concluded

ACTIVITIES FOR WHICH THERE IS QUESTION ABOUT REVERSING THE MULTIPLIER

Activities with Plenty of Data

Time, Seconds	Corrected Multiplier
Item 40	
Slowly	
27	5.0
12	6.6
11	6.8
10	7.0
9	7.5
8*	8.0*
Vigorousness	27
Item 41	
Rapidly	
7	8.0
6	8.5
5	9.0
4	10.0
Vigorousness	31
Total cases	13
Item 50	
26	3.2
25	3.2
24	3.3
23	3.3
22	3.3
21	3.3
20	3.4
19	3.4
18	3.4
17	3.4
16	3.5
15	3.5
14	3.5
13	3.6
12	3.6
11	3.6
10	3.7
9	3.8
8	3.9
7	4.0
6	4.5
5*	5.0*
4	5.5
3	6.0
2	7.0
Vigorousness	23
Total cases	80
Item 51	
30	6
19	10
14	14
Vigorousness	20
Total cases	3
Item 52	
22	3
16	4
11	4.5
10	5
7	7
Vigorousness	21
Total cases	5
Item 53	
23	6
21	6
20	6
12	9
10	10
9	12
6	13
5	14
4	15
Vigorousness	21
Total cases	9
Items 109 and 110**	
10	4
9	5
8	6
5	7
4	8
3	9
Total cases	7
Item 111	
3	1
2	2
Vigorousness	33
Total cases	19
Item 114	
3	3
Vigorousness	32
Total cases	1
Item 124	
21	10
6	14
Vigorousness	23
Total cases	2
Item 126	
26	6
25	6
15	12
Vigorousness	25
Total cases	3
Item 127	
7	15
Vigorousness	24
Total cases	1
Item 129	
23	3
22	3
18	4
13	9
11	11
9	13
8	14
Vigorousness	23
Total cases	7
Item 293	
5	6
6	5
Vigorousness	25
Total cases	2
Item 363	
6	6
12	9
Vigorousness	26
Total cases	2
Item 369	
11	7
Vigorousness	32
Total cases	1
Item 583	
19	3.3
15	3.4
14	3.4
13	3.5
12	3.5
11	3.5
10	3.5
9	3.6
8	3.7
7	3.8
6	4.0
5*	5.0*
4	6.0
3	7.0
2	8.0
Vigorousness	21
Total cases	93
Item 584	
10	3
6	4
5	5
4	6
3	7
Vigorousness	23
Total cases	5
Item 586	
14	2.0
13	2.0
12	2.1
11	2.1
10	2.2
9	2.2
8	2.3
7	2.4
6	2.5
5	3.0
4*	4.0*
3	5.0
2	6.0
Vigorousness	27
Total cases	12

* - Median

** - Vigorousness Scores: Slowly, 19: Rapidly, 27.

ANTHROPOMETRIC STUDIES OF INDIVIDUAL GROWTH
II. AGE, WEIGHT, AND RATE OF GROWTH IN WEIGHT, ELEMENTARY SCHOOL CHILDREN

CARROLL E. PALMER, RIITI KAWAKAMI AND LOWELL J. REED [1]

In a recent paper [2] an analysis was presented of seriatim or "longitudinal" measurements of the height of elementary school children to show the relationship between height already attained and the average annual rate of growth in height. It was shown that:

1. For boys, average annual gains in height decrease regularly from the sixth through the tenth year of age. During this period increments of height are largely independent of height already attained. The well known "adolescent acceleration" of growth, regardless of age, begins somewhat abruptly when boys reach a height of 52 to 53 inches. During this accelerated phase of growth, which continues until a stature of at least 60 to 61 inches is reached, there is a marked positive correlation between the average rate of growth and attained height.

2. For girls, average annual gains in height decrease regularly from the sixth through the ninth year and these gains are independent of attained height. The adolescent acceleration of growth in girls begins when a height of 50 to 51 inches is reached and continues until a stature of 55 to 56 inches is reached. With the attainment of the latter stature there is a marked decrease in growth rates. Throughout the whole of the adolescent period there is a definite association between growth in height and height itself.

3. During the adolescent accelerated phase of growth there is a slight positive association, more marked for girls than for boys, between height and variability of gain in height during the following year.

It is the purpose of this paper to present a similar analysis of seriatim weighings of elementary school children in order to show the relationship between attained weight and average annual growth in weight. More specifically, it is proposed to answer two questions: First, is the annual rate of growth in weight related to absolute weight at the beginning of the year and, if so, does this relationship change with chronological age? Or, expressed differently, are the annual rates of growth in weight a function of attained weight only, attained age only, or of both attained weight and age? Second, to what extent do individuals,

[1] From the Office of Child Hygiene, U. S. Public Health Service and the Department of Biostatistics (Paper No. 210), The Johns Hopkins School of Hygiene and Public Health. Grateful acknowledgment is made for assistance in various parts of the study to Selwyn D. Collins, Morton Kramer and Jacob Yerushalmy. This is the eighth in a series of papers published under the general title, "Hagerstown Growth Studies." Reference to the earlier papers will be found in: Selective Mortality in Childhood, Am. Jour. Hygiene, 21: 608-612. 1935.

[2] Palmer, Carroll E., and Reed, Lowell J. Anthropometric Studies of Individual Growth. I. Age, Height, and Growth in Height, Elementary School Children. Human Biology, 7: 319-324. 1935.

TABLE 1

CONSTANTS OF FREQUENCY DISTRIBUTIONS OF ANNUAL GAINS[1] IN WEIGHT FOR SPECIFIED AGES AND WEIGHTS, ELEMENTARY SCHOOL BOYS, HAGERSTOWN, MARYLAND

Weight Classes[3] lbs	AGE CLASSES[2] 6 - 7			7 - 8			8 - 9			9 - 10			10 - 11			11 - 12			12 - 13			13 - 14			All Ages		
	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases
32	3.83	0.85	3	9.00	-	1	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	5.13	0.64	4
36	4.21	1.67	28	4.22	1.92	25	3.33	1.45	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.17	1.77	56
40	4.33	1.25	56	4.40	1.30	78	4.97	1.90	32	3.56	1.01	8	5.75	2.83	3	4.75	-	1	-	-	-	-	-	-	4.47	1.40	178
44	4.83	1.60	66	5.16	1.51	121	4.57	1.51	99	5.20	2.64	40	2.50	3.49	4	2.75	-	1	-	-	-	-	-	-	4.88	1.68	331
48	5.65	3.19	38	5.13	1.74	132	4.68	1.89	139	4.71	1.72	96	5.22	2.50	32	4.25	1.12	4	4.75	1.00	2	-	-	-	4.94	1.96	443
52	6.00	2.96	17	5.75	2.37	73	5.76	1.69	172	5.36	1.85	135	5.44	2.00	70	4.94	2.28	21	4.75	1.41	3	8.75	-	1	5.58	1.94	492
56	5.33	0.88	3	5.89	2.34	35	5.89	2.45	125	5.80	1.91	149	5.67	1.61	130	4.83	1.57	48	4.08	2.36	9	3.08	2.87	3	5.63	1.96	502
60	-	-	-	7.08	2.61	15	5.86	1.92	57	5.86	1.98	154	6.13	2.36	160	5.41	1.84	80	7.01	3.25	31	6.75	2.38	6	5.96	2.18	503
64	-	-	-	3.75	4.97	4	6.66	3.15	31	5.45	2.23	110	6.05	2.36	124	6.46	2.47	113	5.90	2.23	52	6.33	3.28	12	6.02	2.44	446
68	16.00	-	1	-	-	-	6.90	3.13	10	7.43	3.09	50	6.67	2.74	98	6.94	3.03	97	6.61	2.99	59	7.07	2.82	22	6.91	2.93	337
72	-	-	-	-	-	-	8.44	5.24	8	7.39	3.08	31	7.44	3.63	58	7.94	4.18	97	8.05	4.12	79	9.96	5.36	28	8.02	4.15	301
76	-	-	-	-	-	-	7.40	4.04	5	10.40	4.68	10	7.88	3.91	31	9.55	4.37	54	9.16	4.81	54	10.29	4.88	46	9.34	4.54	200
80	-	-	-	-	-	-	-	-	-	12.80	4.54	5	8.07	4.66	22	9.45	4.58	43	9.00	4.37	53	10.83	5.31	25	9.14	4.64	148
84	-	-	-	-	-	-	-	-	-	12.00	0.50	2	11.00	4.37	16	11.46	6.15	17	11.84	6.57	32	11.75	4.47	32	11.61	5.34	99
88	-	-	-	-	-	-	25.50	-	1	-	-	-	11.75	4.06	4	11.58	6.14	12	12.31	5.91	25	16.61	5.66	21	13.78	5.66	63
92	-	-	-	-	-	-	-	-	-	8.63	3.47	3	8.08	4.96	6	9.95	7.38	13	14.54	6.41	14	11.84	6.57	23	11.53	6.39	59
96	-	-	-	-	-	-	-	-	-	7.25	2.25	2	7.75	-	1	11.89	5.72	7	15.00	6.21	12	12.21	4.63	13	12.69	5.12	35
100	-	-	-	-	-	-	-	-	-	-	-	-	15.75	1.41	3	16.00	9.01	4	15.75	3.57	8	16.31	5.87	9	16.00	5.07	24
104	-	-	-	-	-	-	-	-	-	-	-	-	8.75	-	2	12.75	4.00	5	9.00	1.79	4	16.56	10.23	6	12.75	5.21	17
108	-	-	-	-	-	-	-	-	-	17.25	4.25	2	-	-	-	11.25	1.50	2	0.25	17.00	2	15.38	2.12	8	12.62	4.60	14
112	-	-	-	-	-	-	-	-	-	20.50	-	1	-	-	-	15.25	4.11	6	18.75	3.27	3	14.00	3.35	4	16.02	3.42	14
116	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.25	8.50	2	16.75	2.18	3	17.75	4.70	5
120	-	-	-	5.50	-	1	-	-	-	-	-	-	-	-	-	22.75	-	1	14.25	2.50	2	13.75	-[3]	1	14.10	1.00	5
124	-	-	-	-	-	-	-	-	-	-	-	-	19.75	-	1	-	-	-	17.25	2.50	2	-	-	-	18.08	1.67	3
128	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.75	-	1	-	-	-	-	-	-	12.75	-	1
132	-	-	-	-	-	-	-	-	-	-	-	-	22.25	0.50	2	-	-	-	14.42	2.05	3	21.75	5.72	3	19.13	3.04	8
136	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19.75	-	1	19.75	-	1
140	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21.75	4.00	2	18.75	1.00	2	20.25	2.50	4
144	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.75	-	1	-	-	-	-	-	-	14.75	-	1
148	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
152	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
156	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25.75	-	1	-	-	-	-	-	-	25.75	-	1
160	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25.75	-	1	-	-	-	25.75	-	1
164	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21.75	-	1	21.75	-	1
168	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
172	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
All Weights	4.90	1.68	212	5.15	1.80	485	5.46	2.03	682	5.65	2.14	798	6.46	2.65	767	7.49	3.31	629	8.95	4.14	454	11.49	4.72	270			

[1] Gains are calculated as the difference between weighings made in October each year from 1921 through 1927. The means of the gains represent increases in weight although the individual increments of some of the children represent actual losses in weight. No observations were omitted in these calculations.

[2] The first number of the age class represents the age on the birthday nearest to January 1 of the year for which the increments were calculated. For example, the age class 6-7 represents a group of children who were 6 years of age at their birthday nearest January 1 between the two October weighing days.

[3] The figures given for the weight classes represent a range of weights which begin with the weight class recorded and extend to, but not inclusive of, the weight in the class next below.

TABLE 2

CONSTANTS OF FREQUENCY DISTRIBUTIONS OF ANNUAL GAINS[1] IN WEIGHT FOR SPECIFIED AGES AND WEIGHTS, ELEMENTARY SCHOOL GIRLS, HAGERSTOWN, MARYLAND

Weight Classes[3] lbs	AGE CLASSES[2] 6 - 7			7 - 8			8 - 9			9 - 10			10 - 11			11 - 12			12 - 13			13 - 14			All Ages		
	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases
32	3.83	0.24	3	4.25	1.25	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.11	.91	9
36	4.55	1.44	31	4.50	1.47	26	3.94	1.10	8	5.00	.50	2	-	-	-	-	-	-	-	-	-	-	-	-	4.47	1.38	67
40	4.36	1.48	68	4.08	1.87	107	4.27	1.62	33	3.96	1.46	12	2.75	-	1	2.75	-	1	-	-	-	-	-	-	4.18	1.87	222
44	4.63	1.93	64	4.88	1.70	164	4.61	1.85	134	4.28	1.65	39	3.80	1.75	19	4.42	.48	3	1.75	-	1	8.75	-	1	4.63	1.79	414
48	4.90	2.13	20	5.09	2.34	126	4.93	1.93	176	4.77	2.09	128	5.15	1.94	45	4.90	3.05	13	6.95	2.04	6	-	-	-	4.97	2.09	515
52	6.50	1.06	4	5.61	2.05	53	5.49	2.18	123	5.34	2.32	152	5.74	2.66	89	5.61	2.60	29	7.39	4.35	11	6.75	-	1	5.57	2.36	442
56	4.17	2.12	3	7.09	3.55	17	6.36	2.93	76	6.05	3.05	171	6.43	2.80	137	6.66	3.23	65	8.11	2.31	23	5.75	2.16	3	6.40	2.98	494
60	-	-	-	5.69	4.67	8	7.03	3.93	44	6.70	2.47	96	6.99	2.94	144	7.36	3.18	80	8.56	3.52	26	9.75	1.41	7	7.13	3.05	405
64	1.00	-	1	-	-	-	8.05	3.91	16	8.08	4.59	47	8.31	4.05	103	9.41	3.43	76	9.22	3.10	55	10.33	3.16	19	8.77	3.74	322
68	-	-	-	12.00	2.12	3	10.92	3.65	12	8.84	3.83	32	9.07	3.14	59	9.27	3.94	94	9.75	3.60	45	11.56	3.25	18	9.43	3.63	281
72	-	-	-	10.00	2.50	2	11.38	3.25	4	7.28	4.40	9	10.44	4.68	48	11.68	4.36	69	12.13	4.00	40	12.05	4.33	21	11.37	4.37	193
76	-	-	-	-	-	-	13.50	-	1	9.77	5.60	11	11.08	5.50	28	12.06	4.24	52	12.69	4.08	51	13.22	3.42	19	11.99	4.33	156
80	-	-	-	-	-	-	11.50	-	1	12.50	4.19	7	10.90	5.86	15	13.33	5.43	31	13.17	4.30	36	12.46	3.49	14	12.70	4.69	103
84	-	-	-	-	-	-	9.17	2.06	3	16.50	6.66	4	12.06	3.69	6	14.20	4.99	20	14.05	5.05	30	12.60	4.20	20	13.60	4.72	93
88	-	-	-	-	-	-	-	-	-	9.75	1.31	2	12.35	4.05	5	13.18	5.98	14	12.07	6.05	22	11.25	3.91	14	12.09	5.17	57
92	-	-	-	-	-	-	14.00	-	1	6.17	11.29	3	15.00	7.05	8	13.61	5.06	7	13.71	6.84	22	12.18	5.27	30	12.88	6.13	71
96	-	-	-	-	-	-	-	-	-	4.75	0.25	2	14.09	4.11	5	15.42	6.80	3	15.22	6.17	15	10.84	4.01	11	13.10	5.00	34
100	-	-	-	-	-	-	-	-	-	-	-	-	14.75	2.19	6	17.75	5.42	6	12.95	7.05	10	11.69	7.31	15	13.43	6.24	37
104	-	-	-	-	-	-	-	-	-	-	-	-	19.25	2.50	2	12.75	2.90	5	10.63	5.04	8	13.63	3.98	8	12.88	3.98	23
108	-	-	-	-	-	-	-	-	-	-	-	-	11.75	-	1	17.25	8.50	2	10.42	7.78	6	17.19	6.59	9	14.64	6.83	18
112	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.50	6.87	4	14.75	-	1	8.69	3.63	7	10.85	4.83	12
116	-	-	-	-	-	-	-	-	-	19.00	-	1	-	-	-	21.75	6.00	2	18.85	5.50	2	9.75	9.14	5	14.78	6.87	10
120	-	-	-	-	-	-	-	-	-	-	-	-	8.75	-	1	-	-	-	-	-	-	19.00	1.79	4	16.95	1.43	5
124	-	-	-	-	-	-	-	-	-	-	-	-	18.75	-	1	23.75	-	1	-	-	-	14.75	-	1	20.42	-	3
128	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16.25	3.50	2	-	-	-	8.75	1.41	3	11.77	2.35	5
132	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28.75	-	1	28.75	-	1
136	-	-	-	-	-	-	-	-	-	-	-	-	8.75	-	1	19.75	-	1	-	-	-	-	-	-	14.25	-	2
140	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
144	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
148	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.75	-	1	13.75	-	1
152	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22.75	-	1	-	-	-	22.75	-	1
156	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-.25	-	1	-.25	-	1
160	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.75	-	1	-	-	-	10.75	-	1
164	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
168	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
172	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16.75	-	1	-	-	-	5.25	-	1	5.75	-	2
All Weights	4.55	1.48	194	4.90	2.02	513	5.59	2.29	624	6.08	2.77	717	7.62	3.29	718	9.07	3.91	560	11.34	4.27	410	11.68	4.15	235			

1 Gains are calculated as the difference between weighings made in October each year from 1921 through 1927. The means of the gains represent increases in weight although the individual increments of some of the children represent actual losses in weight. No observations were omitted in these calculations.

2 The first number of the age class represents the age on the birthday nearest to January 1 of the year for which the increments were calculated. For example, the age class 6-7 represents a group of children who were 6 years of age at their birthday nearest January 1 between the two October weighing days.

3 The figures given for the weight classes represent a range of weights which begin with the weight class recorded and extend to, but not inclusive of, the weight in the class next below.

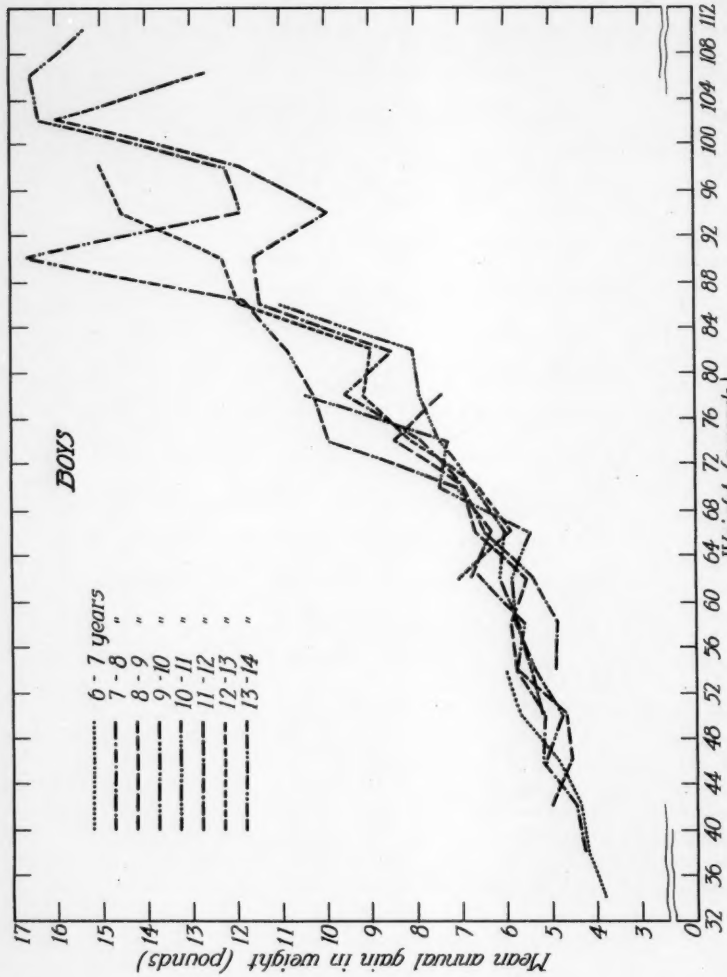

Figure 1. Mean annual rates of growth in weight, specific for age and attained weight.

alike with respect to weight at one age, tend to become different after a year of growth? Or, in other words, what is the dispersing effect of growth?

MATERIAL

The basic material for this paper was derived from the records of an investigation of the growth and health of school children made at Hagerstown, Maryland, by the Child Hygiene Office of the U.S. Public Health Service during a seven year period from 1921 through 1927. Records were made of annual weighings of approximately 2,500 white, native-born, elementary school boys and girls in the month of October of each year. Some of these children were measured twice, some three times, and so on; a few were measured seven times. From these observations it was possible to abstract over 8,000 actual yearly increments of gain in body weight for children between 6 and 14 years of age. Limitation of the study to children between these ages was made although increments were available for children considerably above 14 years of age. This limitation was considered essential because of the well known fact that over-age-for-grade children, such as those who are over 14 years of age in the elementary school, form a selected group with respect to their physical and other characteristics. The inclusion of children in their 13th year, however, would appear to introduce no selective factors which would seriously effect the results of the study. Inclusion of six year old children, who are in school, probably introduces some selective elements since there is some differentiation with respect to physical characteristics of children admitted to the first grade. In view of the fact, however, that the same selective factors generally are operative in all studies of elementary school children, it was considered permissible to include data from all children in the lower age groups. The data, although from selected children, are therefore considered representative of the first eight grades of the elementary school population since the only important selective elements are those which would require a child to be present in school on the days when the annual weighings were made in October. It was not feasible in a study of this magnitude to weigh the children at exactly yearly intervals and the increments were adjusted by simple arithmetic interpolation to cover twelve-month periods. With few exceptions, however, the intervals between measurements were between 11 and 13 months. The dates of birth of the children were obtained from the school records; the age used for each incremental period was the age on the birthday nearest to January first between the consecutive October weighings. Approximately 90 percent of the weighings were made by one individual; the beam scales which were used were carefully calibrated and it may be assumed that errors due to the "personal equation" were of minor importance. Weights were recorded to the nearest quarter pound, and, during the measuring, the children were required to remove shoes, vests, sweaters and coats.

METHOD OF ANALYSIS

The method of analysis is essentially one of correlation, the particular relationship of interest being that between attained weight at the beginning of the year and gain in weight during the following year. Thus, the records of the children were grouped in age and sex specific classes and then into 4-pound sub-groups according to weight at the beginning of the year. Two constants were then calculated for the children in each of the sub-groups; first, the average annual gain

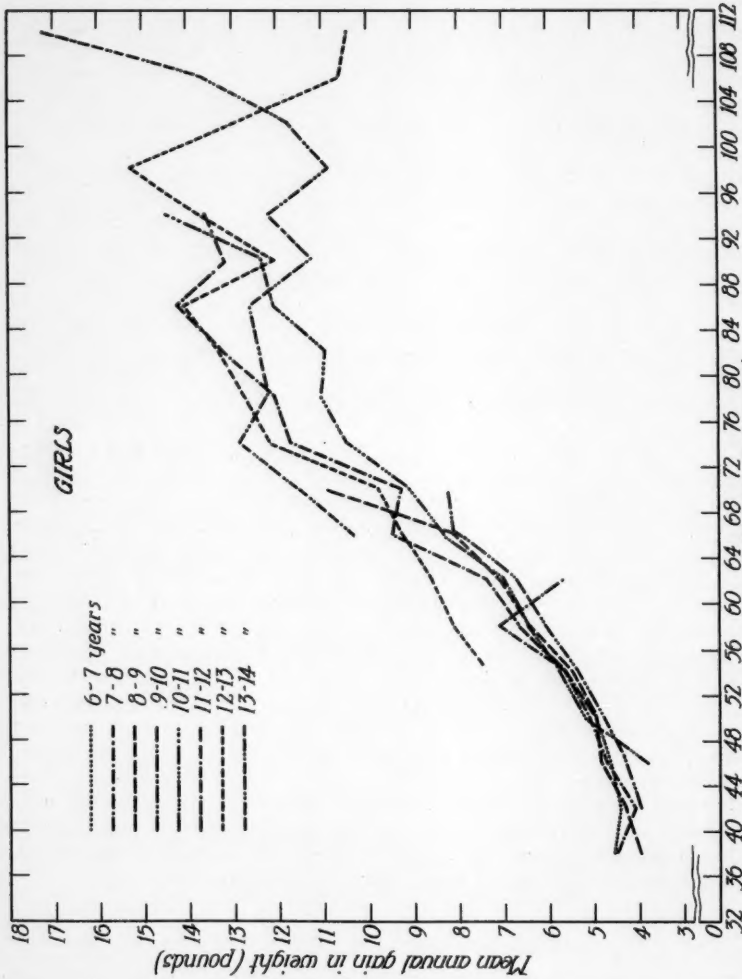

Figure 2. Mean annual rates of growth in weight, specific for age and attained weight.

in weight during the following year and, second, the standard deviation of the annual gains.

Basic data showing the average and standard deviation of annual gains and the number of children for each age and sex and weight subgroup are shown in Tables 1 and 2. A specific example of the method of reading the values given in these tables may facilitate their interpretation. In the upper left hand section of Table 1, to the right of the marginal heading "32" and below the heading "6-7", are given three items: the mean, the standard deviation "Stand Dev" and the number of cases "No" for the group whose age was six years at the beginning of the year and was seven years at the end of that period. The figures given there show that three boys, whose weights in October were 32 pounds but less than 36 pounds and whose age at their nearest birthdays on the following January first was six years, gained between the two successive October weighings an average of 3.83 pounds and that the standard deviation for the distribution of gains of these three boys equalled 0.85 pounds. The numbers given in the lowest horizontal row in Tables 1 and 2 are the weighted mean gains, the average weighted standard deviations[3] of gains and number of children for each of the age classes, irrespective of the actual weight of the children at those ages. The numbers given in the vertical columns at the extreme right of the tables are, similarly, the weighted mean gains, the average weighted standard deviations[3] and the number of individuals, for groups of children of the same weight, irrespective of age.

In order to provide statistical data of possible use to future workers, Table 3 gives the means, standard deviations and numbers of cases for the distribution of actual body weights for children in the different age classes. These data, together with those given in the marginal arrays of Tables 1 and 2, furnish the essential constants needed to reconstruct the principal parts of the correlation tables on which the paper is based.

TABLE 3

Constants of Frequency Distributions of Observed Weights for Specific Ages. Elementary School Children, Hagerstown, Maryland

Age	Boys			Girls		
	Mean lbs	Stand Dev	No	Mean lbs	Stand Dev	No
6	45.45	5.11	212	44.04	4.60	194
7	48.93	6.57	485	47.36	5.58	512
8	54.12	7.04	682	52.62	7.24	624
9	59.75	8.75	798	57.69	8.75	717
10	65.21	10.32	767	63.60	11.08	718
11	71.82	12.52	629	70.99	13.81	590
12	78.44	14.18	454	77.42	14.88	410
13	85.26	15.65	270	88.51	18.81	233

[3] These standard deviations are simply the averages of those given in the appropriate arrays, weighted for the number of cases from which the individual standard deviations were calculated.

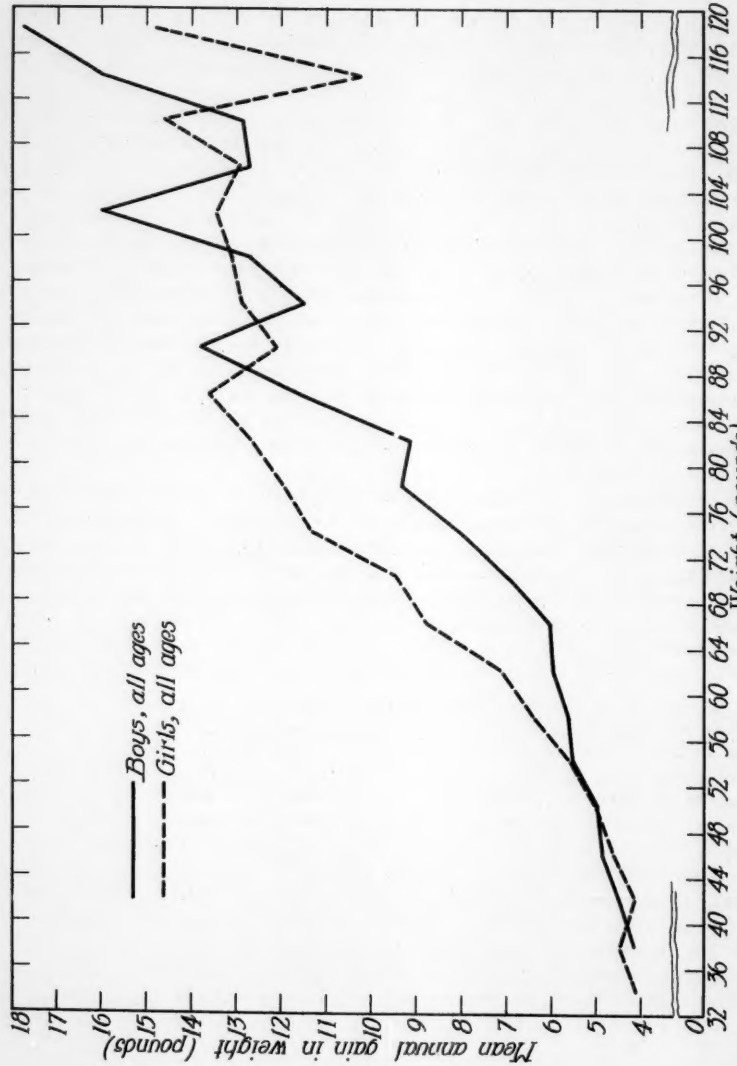

Figure 3. Mean annual rates of growth in weight, specific for attained weight. All ages, 6 through 13 years.

MEAN ANNUAL RATE OF GROWTH

The relationship between weight attained at a given age and average gain in weight during the following year is shown graphically for boys in Figure 1,[4] and and for girls in Figure 2. Except for certain differences in the older age groups, the principal characteristic of the relationship is clear, namely, growth in weight is more dependent on weight attained than on chronological age. In general the lines which describe the gains for the younger children fall closely together and tend to cross and recross each other without any consistent differentiation for the specific age classes. Certainly for boys from 6 to 11 years of age and for girls from 6 to 10 years of age weight already attained is a primary factor influencing gain during the following year. For both boys and girls, but to a lesser extent for boys, there is considerable fluctuation of the lines for the older age groups. Part of this fluctuation is due to the great variability of gains during this period of growth and represents only sampling variation. In spite of the sampling variation, however, the general pattern of the lines indicates that age is also an influential factor in growth of the older age groups. If the mean annual rates for boys in the 72-76 pound weight class are examined, for example, it is found that the average increments increase slightly in each successive age group. The same general finding is observable in the weight groups above this for boys and for a considerably wider range of weight groups for girls. Particular attention may be directed in this connection to the lines for the 12-13 year and 13-14 year old girls. These age groups represent a period characterized by the beginning of the menses for the majority of the girls and it is clear from the evidence presented here, supplemented by considerable collateral evidence, that other factors enter the growth process which are not present either before or after this period. The general finding of a direct and close relationship between attained weight and growth in weight is observable, however, for the 12-13 year group. The line representing the growth of girls in the 13-14 year group, on the other hand, remains relatively horizontal, indicating that for this group there is essentially no positive association between attained weight and growth.

It is not considered necessary at this time to discuss all of the details which appear in the tables. Certain points, however, may be mentioned. Thus, it is evident that growth in weight between 6 and 14 years of age is dependent both on age and on weight already attained. In boys, age apparently has little influence on average growth during the time that weight changes from 32 to 72 pounds. In girls, similarly, age has little effect on growth during the time that weight changes from 36 to 60 pounds. Increase in weight above these limiting values, in general, depends on both age and attained weight. A detailed analytical separation of the relative influence of these two factors, however, presents difficulties.[5] The importance of considering the implications of the general findings may, nevertheless, be indicated. Obviously, the usual method of expressing growth increments only in terms of gains for specific age groups may be quite unsatisfactory in many practical problems. If, for example, the growth of a group of

[4] In Figures 1, 2, 4 and 5, irregular values based on only a few cases are omitted from the graphs. No data, however, are omitted from the tables.

[5] It is considered sufficient at this time to state that attempts to derive mathematical expressions to represent the individual curves shown in Figures 1 and 2 and the composite curve in Figure 3 have not been successful.

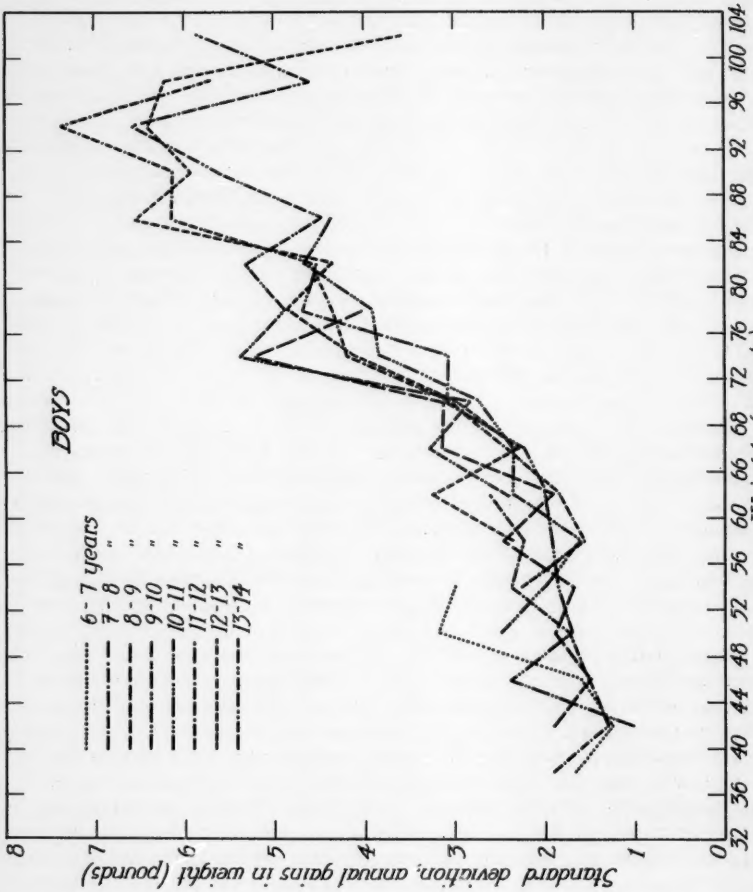

Figure 4. Standard deviations of annual gains in weight, specific for age and attained weight.

underweight or malnourished children is studied, quite erroneous conclusions may be reached if gains in weight are compared only with age specific increments. In the light of findings presented here it would appear to be necessary in many problems to take account of both age and attained weight. In some problems, however, it may be impractical to attempt to partial out both age and attained weight. Under such circumstances, the results of the present analyses indicate that if only one variable can be considered, more satisfactory results will be obtained by making the analyses specific for attained weight alone rather than for age alone. Thus it is shown that the gains of 10 year old girls vary from 5 to 14 pounds per year depending on whether the girls weigh 50 or 90 pounds at that age. The calculated average gain of 7.62 pounds per year for girls between their 10th and 11th year would furnish in many instances a highly unsatisfactory standard. In view of these circumstances, the average gains for children of the same weight but of different ages was calculated and reported in the tables. These data are presented graphically in Figure 3. According to this analysis, boys and girls gain in weight at essentially the same rate until both attain a weight of approximately 54 pounds. During the time that 30 pounds are added to their weights or until both attain a weight of approximately 85 pounds, girls grow more rapidly than boys of the same weight; both sexes grow at about the same rate after weights of 90 pounds are reached.

DISPERSING EFFECT OF GROWTH

Standard deviations of observed gains, as given in Tables 1 and 2, provide not only the usual measures of variability, but also quantitative measures of the tendency for individuals, alike with respect to weight at the beginning of the year, to become differentiated after a year of growth. The children included in the separate sex and age and weight sub-groups make up homogeneous classes of individuals; they are alike with respect to age and sex and, within four pounds, they weigh the same amount. At the end of a year of growth they have gained variable amounts in weight. Since the standard deviations are based on actual gains for homogeneous groups, they measure differences in growth and serve as indexes of the differentiating or dispersing effect of growth. Furthermore, since the grouping of the children into 4-pound sub-groups according to weight at the beginning of the year subdivides the population into many homogeneous classes, a study of these standard deviations may give a rather complete picture of the dynamics of the dispersing effect of growth during the whole of the growth period from the 6th to the 14th year of age. Although these indexes of the dynamics of growth may be utilized in a number of ways in the study of growth processes, the present paper will contain only a limited graphic analysis of the relationship between the dispersing index and age, sex and weight at the beginning of the year. Accordingly, Figures 4 and 5 show graphically the same analysis for the standard deviations of gains as was shown in Figures 1 and 2 for mean gains.

Viewing the data for boys (Figure 4), it will be noted that the lines representing standard deviations for the various age groups are superimposed upon each other to such an extent as to suggest that age is not a primary factor in the relationship. Between the weight range of 36 to approximately 90 pounds, it is reasonably clear that despite the irregular fluctuations which are due largely to sampling variations, the indexes of dispersion depend primarily on attained weight

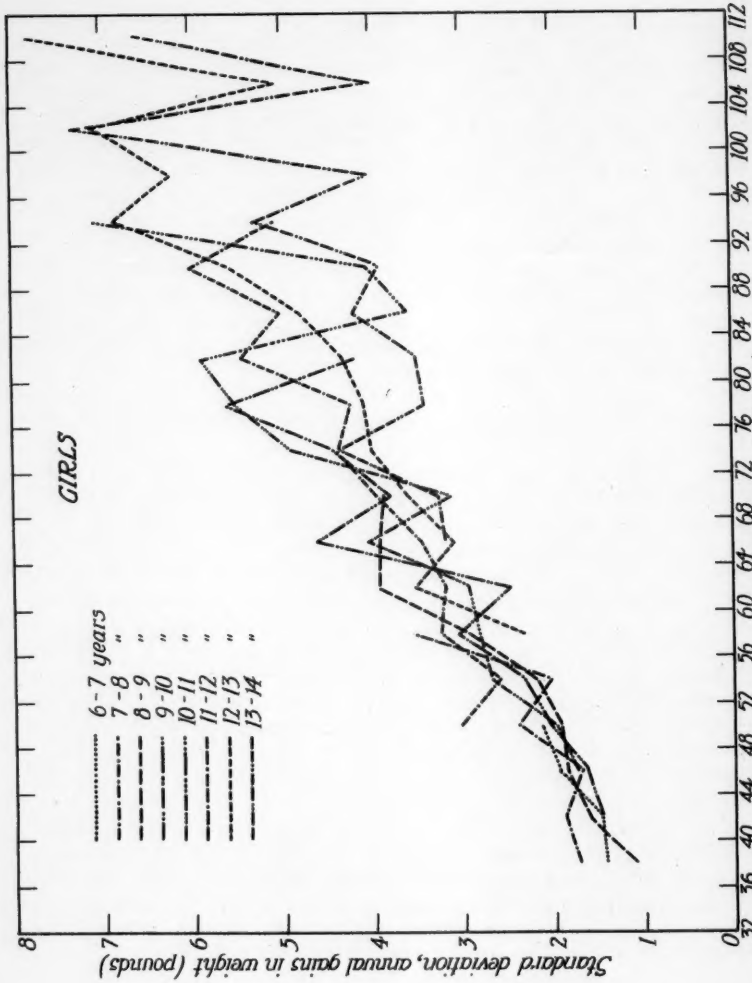

Figure 5. Standard deviations of annual gains in weight, specific for age and attained weight.

and that the dispersive effect of growth increases directly with increase in weight. The paucity of data for weights above 90 pounds does not permit a definite statement of the relationship.

An examination of the material for girls, presented in Figure 5, reveals essentially similar findings as those outlined for boys. The greater irregularity of the lines for the girls is indicative of the well known fact that growth of girls shows greater variation than growth of boys. It is probably permissible, however, to conclude that throughout the weight range from 36 to 86 pounds, the dispersive effect of growth increases regularly with increase in attained weight and that age is not an important determining factor in the relationship. Above the weight of 86 pounds the standard deviations for girls show great variation, probably because of the inadequacy of the data.

Since age appears to be only an incidental factor in determining the tendency for individuals of the same weight to differ after a year's growth, averages of the indexes of dispersion were calculated for each of the weight classes, disregarding age. The results of these calculations are shown in Figure 6. The averages of the dispersion index for girls follows very closely a straight line relationship throughout the range from 32 to 86 pounds. After the latter weight is attained, the line representing the relationship tends with considerable irregularity to become horizontal. The line, representing the changes of the index with increasing weight for boys, follows closely the line for girls until a weight of approximately 50 pounds is reached by both sexes. From this point until a weight of 72 pounds is attained, the line for boys is considerably lower than the line for girls, indicating that the dispersing effect of growth is less in boys than in girls of the same weight. Above weights of 72 pounds, the indexes for the two sexes are much alike, except that the dispersion is greater in boys in the weight range from 82 to 98 pounds.

In connection with the study of the indexes of dispersion, one additional point may be made, namely, that there would appear to be a marked positive association between the standard deviations and the means of the annual increments. Thus the curves shown in Figures 3 and 6 are very similar and led to the suggestion that changes in average gains in weight are accompanied by similar changes in variability of gains. An analysis of the correlation between means and standard deviations of increments, although showing clearly the presence of a positive association, does not reveal additional information of sufficient importance to warrant its inclusion in the paper.

SUMMARY

This paper represents the second part of a "longitudinal" study of growth. The first paper of the study contained an analysis of the relationship between height and growth in height of elementary school boys and girls. It was shown that growth in height is primarily dependent on chronological age between the sixth and tenth year in boys and the sixth and ninth year in girls. From the upper limits of these intervals of age, until the fourteenth year is reached, growth in height of both boys and girls shows a marked positive correlation with height already attained. It was shown, also, that there is a slight correlation between

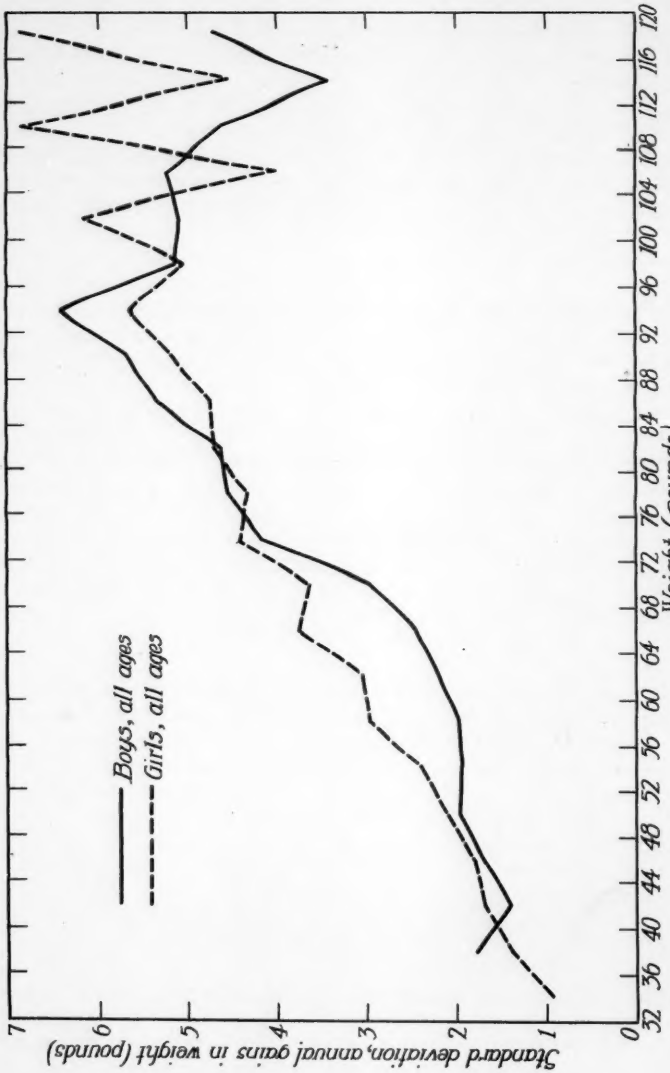

Figure 6. Standard deviations of annual gains in weight, specific for attained weight. All ages, 6 through 13 years.

the variability of growth in height and height itself.

The present paper consists of a similar analysis of the relationship between body weight already attained and growth in weight. The study is based on approximately 8,000 observed annual increments in body weight of elementary school boys and girls between the ages of six and fourteen years. A tabular and graphic analysis of these data in age and sex and weight specific classes show the following:

1. During the period of growth in which boys increase from 32 to 68 pounds in weight and girls increase from 32 to 60 pounds, the primary factor which influences growth is body weight already attained. When weight reaches the upper limits of these ranges, growth is influenced by attained chronological age, although attained weight is still the stronger factor in growth.

2. Standard deviations of distributions of annual increments, which in this study serve as indexes of a dynamic force termed the "dispersing effect of growth," are found to be strongly correlated with both attained weight and growth in weight.

Applications of the investigation are pointed out and it is indicated that in many practical studies on children it is necessary to consider attained weight in evaluating growth in weight.

AN EVALUATION OF VARIOUS INDICES OF LINGUISTIC DEVELOPMENT

JOHN E. ANDERSON [1]

In 1933 La Brant,[2] using as material compositions written by children in the fourth to the twelfth grades, published an interesting study of language development. She obtained an index of subordination by dividing the number of subordinate predicates by the total number of predicates in compositions of approximately 150 words. She found that the index of subordination increased with mental age and with chronological age, the curve for mental age rising from 8 1/2 years to 13 1/2 years and then falling off, while the curve for chronological age rose steadily from 8 1/2 years to 16 years. Although on the whole the girls showed a slightly higher index of subordination than the boys, at different age levels the relationship between the indices for the sexes varied. No evidence was found to support Jespersen's statement that subordination is more characteristic of males than of females.

Preliminary to a more detailed study of the development of written language in children the investigation reported in this paper was undertaken to solve several methodological questions. La Brant used a single composition and did not check the consistency of the Index of Subordination by comparing different compositions written by the same children. Although no children's compositions were immediately available for our study, it was found that in a course in composition in the General College of the University of Minnesota,[3] students were accustomed to write a preliminary draft of their compositions in notebooks which were then made available to the instructor before extensive criticism or correction was undertaken. As the choice of the theme was left to the individual these compositions dealt with a wide variety of subjects. From four different sets of compositions, sections of approximately 150 words (to the nearest complete sentence) were selected. These are hereafter designated as compositions 1, 2, 3, and 4, in the order in which they were written. From the first composition an additional section of approximately 150 words, coming immediately after the first 150 words, was selected. This section is called composition IA. For each individual, then, parts of four different compositions and an additional part of one composition were available. Compositions were obtained for a total of 111 students, of whom 56 were males and 55 females. Their ages ranged from 16 to 24 years with a mean of 19 years 4 months and a standard deviation of 17.9 months. In addition for all students percentiles in the Minnesota college aptitude test and in the Iowa English test were available. For 87 students high school ranking percentiles were also available. For this study percentiles were converted into sigma scores.

In addition to the index of subordination obtained by the La Brant method, the mean length of sentence for each individual and the standard deviation of sentence length from this mean were determined, together with a personal pronoun index

[1] From Institute of Child Welfare, University of Minnesota.

[2] La Brant, Lou L. A study of certain language developments of children in grades four to twelve, inclusive. Genetic Psychology Monographs 14:387-491. 1933.

[3] Appreciation of the interest and cooperation of Mr. Francis S. Appel, Instructor in English in the General College, is expressed.

obtained by dividing the number of personal pronouns in each passage by the total number of pronouns used in the selected sample of writing. Since second person pronouns were almost completely absent from the compositions, this index is virtually one which shows the ratio of first person pronouns to first and third person pronouns combined.

Table I presents the correlation coefficients* showing the interrelation of length of sentence in the different compositions. All coefficients are positive

TABLE I

INTERCORRELATIONS OF LENGTH OF SENTENCE IN SEVERAL COMPOSITIONS

	Composition			
	1	2	3	4
Composition 2	+.50			
Composition 3	+.24	+.20		
Composition 4	+.34	+.33	+.31	
Composition IA	+.35	+.16	+.36	+.32

but relatively low. The reliability coefficient determined from compositions I and IA is +.35 and the mean of the coefficients for the interrelations of all the compositions (exclusive of the coefficient between I and IA) is +.31. Since length of sentence is an objective measure obtained by counting, the obvious conclusion is that a passage 150 words in length is insufficient to obtain a characteristic or stable measure of sentence length.

Similar coefficients for the standard deviation of sentence length are presented in Table II. Again the coefficients are all positive and low. They are

TABLE II

INTERCORRELATIONS OF S.D. OF SENTENCE LENGTH FOR SEVERAL COMPOSITIONS

	Composition			
	1	2	3	4
Composition 2	+.12			
Composition 3	+.15	+.05		
Composition 4	+.18	+.27	+.07	
Composition IA	+.24	+.17	+.24	+.03

lower than those similarly obtained for length of sentence undoubtedly because of the intrinsic relation between the standard deviation and the mean. The reliability coefficient determined from compositions I and IA is +.24 and the mean of the coefficients for the relationships between the various compositions (exclusive

*All correlations are Pearsonian product-moments.

of the coefficient between I and IA) is +.14. Since this standard deviation is a function of sentence length it, too, is objective. A sample of 150 words is, then, too brief for obtaining a stable measure of variability in sentence length.

In Table III similar coefficients are presented for the index of subordination. The correlations are low and with one exception positive. The reliability coefficient for compositions I and IA is +.23. La Brant obtained a reliability coef-

TABLE III

INTERCORRELATION OF SUBORDINATION INDEX FOR SEVERAL COMPOSITIONS

	Composition			
	1	2	3	4
Composition 2	+.11			
Composition 3	+.22	-.08		
Composition 4	+.05	+.05	+.04	
Composition IA	+.23	+.05	+.10	+.05

ficient of .61 (rank differences) or .63 (Pearsonian) for 21 samples of the published writing of psychologists. She, however, used 300-word samples in this portion of her study and points out that the finished product of experienced writers may not be comparable with that of children. The mean for the interrelations between the compositions, exclusive of the coefficient for I and IA, is +.07. These coefficients are surprisingly low and indicate that the index of subordination needs further study. Two factors are involved. The data on the length of sentence and the standard deviation of sentence length indicate that a sample of 150 words is inadequate for measures which are completely objective in their determination. Over and above this inadequacy of sample there is the further factor of a subjective element in the judgments upon which the index is based.

In our study the compositions were typed triple space on single sheets of paper. All coordinate predicates were underlined in black and all subordinate predicates in red. Wherever a question was raised as to the classification of a particular predicate, it was discussed with another person and an agreement reached as to the classification. As a check, composition I was retyped and given to a third person, who, after a general discussion of the criteria, marked the papers without further consultation. The correlation coefficient obtained for inter-person marking of the same passage is +.70, a figure sufficiently high to indicate inherent possibilities in the method. It is quite likely this coefficient could be substantially increased if a scale were prepared showing how doubtful constructions were to be classified.

In Table IV, coefficients for the pronoun index are presented. Although this index has much greater reliability for a single composition, as shown by the coefficient of +.61 between I and IA, the correlations between various samples of writing are extremely low. The mean coefficient for the interrelations of this index, exclusive of the coefficient for I and IA, is +.11.

TABLE IV

INTERCORRELATIONS OF PRONOUN INDEX FOR SEVERAL COMPOSITIONS

	Composition			
	1	2	3	4
Composition 2	.00			
Composition 3	+.02	+.09		
Composition 4	+.17	+.19	+.25	
Composition IA	+.61	+.05	+.04	+.20

In measuring a language product still another factor must be taken into account, namely the relationship between language and the situation or circumstances in which it is produced or the subject matter with which it is concerned. The high coefficient for compositions I and IA indicate that the pronoun index is fairly consistent within a single composition, but is worthless or of only slight value in predicting the index for another composition written at a different time and on a different subject. This factor undoubtedly operates in all the indices treated here. Language in its very nature is an extraordinarily flexible and adaptable instrument. To be sure, it is affected to some degree by personal standards of style and treatment. But even in a writer with a very consistent style there is undoubtedly a wide range of adaptation to situation and subject matter, with consequent variation.

THE INTERRELATION OF MEASURES

The interrelations of all the measures of language obtained, i.e. length of sentence, standard deviation of sentence length, index of subordination, and pronoun index were obtained for each composition. Since the resulting correlation tables are very similar, only the means are presented in Table V. Each coefficient in this table is the mean of the five coefficients obtained from compositions I, IA, 2, 3, and 4, respectively.

TABLE V

INTERRELATIONS OF LANGUAGE MEASURES

	Length of Sentence	S.D. of Sentence	Index of Subordination
S.D. Sentence	+.51		
Index of Subordination	+.49	+.30	
Pronoun Index	-.01	-.02	+.13

The mean of the coefficients for the relation between standard deviation of sentence and length of sentence, which is +.51, indicates that standard deviation of sentence length varies with the length of the sentence, as was to be expected. Sentence length varies more in the compositions in which long sentences are used than in those with shorter sentences.

The coefficient for the relationship between length of sentence and index of subordination, which is practically the same, +.49, shows that those who use longer sentences also tend to use more subordinate clauses. The relationship between standard deviation of sentence length and the index of subordination is consistently lower, being +.30 and indicates that while the use of subordinate clauses is a contributing factor in variations in sentence length, it is not the only factor. In general, sentences containing subordinate clauses seem to be longer than those containing coordinate clauses. Many students of style, including La Brant, have suggested that in the development of style there is a strong tendency to substitute subordination for coordination.

The personal pronoun index shows no relationship whatever to length of sentence or to the standard deviation of sentence length, the coefficients closely approaching zero. The small relationship (+.13) between the index of subordination and the pronoun index suggests a slight tendency in writers employing the first person to use more subordinate predicates than are used by those who write in the third person.

RELATIONSHIP OF INDICES TO OTHER FACTORS

Coefficients were calculated for the relationship between the various indices and chronological age, college aptitude scores, Iowa English scores and high school rank, for each of the indices and each of the compositions. The mean of all these coefficients are presented in Table VI.

TABLE VI

CORRELATIONS OF LANGUAGE MEASURES WITH OTHER MEASURES

	Length of Sentence	S.D. of Sentence	Index of Subordination	Pronoun Index
Age	+.06	+.02	-.04	-.04
College Aptitude	+.01	+.04	-.06	-.03
Iowa English	+.12	+.15	-.02	+.06
High School Rank	+.10	+.10	-.02	+.01

These approximate zero and indicate that there is no essential relationship between any of the indices used and the other measures available for the individuals in the very homogeneous group studied here. Length of sentence and standard deviation of sentence length seem to be slightly related to Iowa English scores and to high school rank.

SEX DIFFERENCES

Means were determined for each sex for language measures and each of the general measures used in this study and are presented in Table VII.

In general the girls show a consistent but slight tendency to use longer sentences, to vary their sentence length more, to use more subordinate clauses, and to use more personal pronouns. With but three exceptions out of the twenty

TABLE VII

COMPARISON OF SEXES

	Male	Female	Diff/σ Diff.
Length of Sentence	20.2	20.6	+.34
S. D. Sentence	8.2	8.7	+.73
Index of Subordination	49.3	50.2	+.32
Pronoun Index	47.7	53.8	+.90
Age	19.6	19.3	-.88
College Aptitude	41.3	43.6	+1.60
Iowa English	40.7	47.1	+4.30
High School Rank	44.8	49.4	+2.58

determinations on the individual compositions the differences all favor the girls. But it should be noted that the differences are of such slight significance when the Diff/σ diff. is calculated that they are probably meaningless. And when they are compared with the differences for the sampling data available for the groups shown in the last half of the table, it becomes clear that they are of no significance whatever.

Certainly there is no support here for the contention of some grammarians that linguistic skill as measured by the tendency to subordination is present in smaller amount in girls than in boys.

Although this study points out certain limitations of the index of subordination, when obtained on a short sample of written composition, in my opinion, it does not question the validity of the results obtained by La Brant so far as the chronological age and mental age relationships of the index are concerned. The subjects in this study are well beyond the period at which, according to her study, the developmental curve flattens out. In younger individuals the change in language with age may be so marked that it is apparent even when essentially unreliable measures are used.

The difficulties involved in the use of the index of subordination are apparent when we consider the results of both investigations in terms of the size of the indices obtained. La Brant used two groups of subjects. For her child subjects the highest median index, 36.25, was obtained for those 16 years old. On her group of twenty-one adult psychologists, for whom two passages from the Psychologies of 1930 were analyzed, the mean subordination index for the first sample was 45.3 and that for the second sample 46.5. The mean indices obtained on the basis of the first marking in our study lie between 46 and 51 for the various compositions. For composition IA the first marker obtained a mean subordination index of 50.20, whereas a second marker obtained a mean index of 38.13, which is in much closer agreement with what might have been expected from the La Brant results. Examination of the papers indicates that the chief difference lies in the interpretation of infinitives, many of which were construed by the first marker as subordinate predicates and were not so construed by the second. Although La Brant made a special study of infinitives, she does not make perfectly clear how they were handled in calculating the subordination index. Despite our attempt to follow

the La Brant technique closely, our interpretation of subordination was evidently less rigorous than hers. In the absence of a very detailed description of how specific clauses and phrases are to be rated, it is obvious that the level of the subordination index will be subject to variation depending upon the interpretations made by those using it. It should also be noted that our test of the index of subordination is the most rigorous that can be applied. Whereas La Brant used compositions written on the same topic, we used compositions as we found them regardless of topic. We were interested in the generality of the index in the hope that an easily applied and uniform measuring implement could be developed. Although our study indicates that this is probably out of the question, it leaves open a fertile field for the development of indices based on common subject matter, well categorized scales, and adequate samples from the standpoint of length of passage.

SUMMARY

1. A written passage approximately 150 words in length does not constitute an adequate sample for the study of written language. Measures that can be determined with maximum objectivity, such as length of sentence and standard deviation of sentence, show low positive relationships with those obtained on similar passages taken from other compositions, while indices in which a subjective element enters show even lower relationships.

2. The results suggest that within the language product of a single individual indices of written language vary with the situations in which language is used and with the subject matter.

3. The indices here considered show some interrelation with each other. Length of sentence, standard deviation of sentence length, and the index of subordination are positively related. The pronoun index is not related to the length of sentence or to standard deviation in sentence length but is slightly related to the index of subordination.

4. For the highly selected group of subjects used in this study, none of the indices show significant relationship to age, college aptitude, Iowa English Scores, or high school rank.

5. No significant relationship between sex and the linguistic indices studied was found.

MEAN SENTENCE LENGTH COMPARED WITH LONG AND SHORT SENTENCES AS A RELIABLE MEASURE OF LANGUAGE DEVELOPMENT

EDITH A. DAVIS [1]

Although the mean length of sentence is a very valuable index of language development, it does not give due weight to sentences which lie at the extremes of the distribution. In analyzing 21,800 remarks of 436 children[2] the writer found that nearly 20 per cent were of only one word, while on the other hand there were many sentences which reached 20, 30, and even 50 words. These very long and very short remarks are here compared with mean sentence length from the standpoint of reliability and the portrayal of group differences in development.

At the upper end of the scale the sentences considered were each child's longest sentence and the mean of each child's five longest sentences. In this way all subjects were equally represented in the analysis, and group differences which might have been misinterpreted if long sentences had been arbitrarily defined as those exceeding 8, 10, or 12 words in length became meaningful. Although such a method might give a clearer picture of the characteristics of long sentences, the consequent elimination of many of the subjects (because no sentences over the arbitrary limit were present in their records) would have nullified the careful selection of cases on a cross-section basis.

Since 10 per cent of each child's remarks were considered long sentences for that child, the variability in the length of the long sentences studied was necessarily great. The range in longest sentences was from 2 words for a kindergarten child who could hardly talk at all to 56 words for a fourth grade girl. The mean of the 5 longest remarks ranged from 1.4 to 36.4 words. The mean and the reliability of the mean of long sentences at each age level studied, as well as that for the mean of 50 remarks, will be found in Table I.

TABLE I

INCREASE IN SENTENCE LENGTH WHEN MEASURED BY THE LONGEST, THE MEAN OF 5 LONGEST, AND THE MEAN OF 50 REMARKS

Subjects		Longest Sentence			Mean of 5 Longest			Mean of 50 Remarks		
Age in years	No. of Cases	Mean no. of words	S.D.	S.D.m	Mean no. of words	S.D.	S.D.m	Mean no. of words	S.D.	S.D.m
5 1/2	248	13.5	5.79	.37	10.3	3.52	.22	4.57	1.41	.09
6 1/2	63	16.2	5.84	.73	12.2	3.36	.42	5.28	1.37	.17
9 1/2	125	20.2	8.79	.79	15.6	5.48	.49	6.55	2.30	.20

[1] From Institute of Child Welfare, University of Minnesota.

[2] Davis, Edith A. The Development of Linguistic Skill in Twins, Singletons, with Siblings and Only Children. University of Minnesota, Institute of Child Welfare Monograph Series Number XIV. In Press.

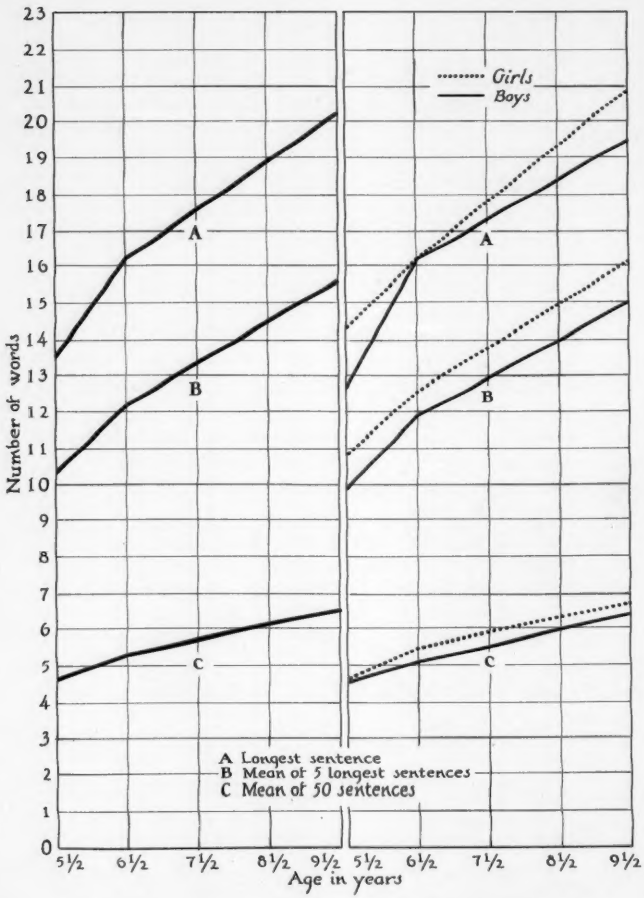

Figure 1. Increase with age in length of longest, the mean of 5 longest, and the mean of 50 remarks.

Figure 2. Increase in length of longest, mean of 5 longest, and mean of 50 remarks for boys and for girls.

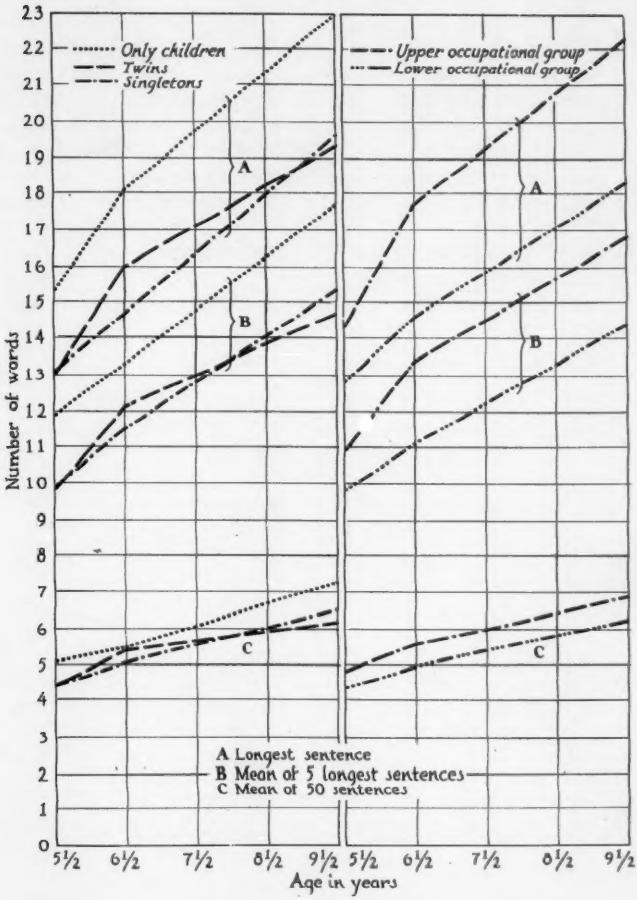

Figure 3. Increase in length of longest, mean of 5 longest, and mean of 50 remarks for twins, singletons, and only children.

Figure 4. Increase in length of longest, mean of 5 longest, and mean of 50 remarks for children from upper and lower occupational groupings.

Although all the measures show development from year to year Figure 1 indicates that the increase is more noticeable in long sentences than in the mean of 50 remarks.

The superiority in mean sentence length of girls, only children, and children from the upper occupational groupings, which was found in the major study become even more clear when long sentences are the method of measurement. These findings are presented in Figures 2, 3, and 4. Similarly, the difference in mean sentence length between kindergarten children with perfect and faulty articulation reported in the major study was found to exist when the groups were compared for the longest and mean of 5 longest sentences, and for the number of one word remarks. Articulatory difficulties, usually of the infantile type, were present in 88 of the 248 subjects at the 5 1/2 year age level. The mean sentence length for the perfect group was 4.85 words, and for the faulty group 4.00 words, with a critical ratio between groups (D/S.D. diff.) of 4.39. Table II shows the consistency of this difference when the sampling includes only very long or very short remarks.

TABLE II

COMPARISON OF VERY LONG AND VERY SHORT REMARKS OF CHILDREN AT 5 1/2 YEARS ON THE BASIS OF ARTICULATION

Group	Number of cases	Mean length longest	Mean length of 5 longest	Number of one-word remarks
Faulty	88	11.7	9.06	11.83
Perfect	160	14.5	11.03	9.70

At each age there is a slight positive relationship between length of sentence and intelligence. This correlation, calculated by the Pearson product-moment method, is very constant whether the unit of measurement is the longest, the mean of 5 longest, or the mean of 50 remarks. Table III gives the exact relationship.

TABLE III

CORRELATION BETWEEN IQ AND SENTENCE LENGTH

Age in years	Longest sentence	Mean of 5 longest	Mean of 50
5 1/2	.20	.24	.48
6 1/2	.36	.22	.21
9 1/2	.20	.19	.20

The measure of short sentences used was the number of single word remarks for each child. The relationship between number of single word responses and IQ is slightly negative, and the mean number of such responses decreases somewhat with age. These findings are summarized in Table IV.

TABLE IV

MEAN NUMBER OF SINGLE WORD RESPONSES

Age in years	Mean	S.D.	S.D.m	Correlation with IQ
5 1/2	10.90	8.35	.56	-.19
6 1/2	9.30	7.04	.89	-.03
9 1/2	8.34	2.94	.28	-.36

The critical ratio (D/S.D. diff.) between the number of such responses at 5 1/2 and at 9 1/2 years is 4.06, which satisfies the criterion usually set up for statistical reliability.

Throughout the analysis of the data the writer was impressed by the consistency of sentence pattern for individual children. That is, a child whose mean length of sentence was long tended to use many long sentences, rather than a few long ones and the rest short. Conversely, a very long sentence was seldom found in the record of a child whose mean length of sentence was short. Statistical verification of this impression was obtained by the calculation of reliability coefficients. Since a child's remarks tended to increase in length as he became more at ease in the experimental situation, the data, consisting of 50 remarks for each child, were divided by the odd-even method, rather than by taking first and second halves. The longest sentence, the mean of the 5 longest sentences, the mean of all 25 sentences, and the number of one word remarks in the odd section were correlated, using the Pearson product-moment formula, with the corresponding measures in the even section. Since this method takes account of only one-half the actual data, the coefficients were corrected by using the Spearman-Brown prophecy formula. The findings are summarized in Table V.

TABLE V

RELIABILITY COEFFICIENTS OF FOUR MEASURES OF LANGUAGE DEVELOPMENT

Age in years	Longest	Mean of 5 longest	Mean of 25	Number of one-word remarks
5 1/2	.59	.84	.91	.94
6 1/2	.73	.84	.87	.79
9 1/2	.86	.92	.95	.87

It appears that the longest sentence is least reliable and the mean of 25 sentences is most reliable at each age. In general, the language of the child at 9 1/2 years seems to have become somewhat more uniform in pattern than is the case with younger children. For certain purposes the number of one-word remarks in a given sample of spoken language would seem to be a satisfactory and easily calculated measure of language development. The mean of 5 longest remarks shows development so clearly and is so nearly equal in reliability to the mean of the entire sample, that it should be seriously considered as a measure in future

studies of language.

Among the subjects at the 5 1/2 year age level were 36 pairs of like-sex twins. Since the similarity between members of such pairs in many mental traits is well established, a comparison was made of the correlation between members of twin pairs with that between the two halves of the data for the same individuals, using the method for correlating interchangeable variables devised by Goodenough.[1] For all the measures under consideration there is an appreciable relationship between twin pairs, but the reliability of the two halves of the data is much greater, as may be seen in Table VI.

TABLE VI

COMPARISON OF THE RESEMBLANCE BETWEEN LIKE-SEX TWINS AT 5 1/2 YEARS WITH THE ODD-EVEN RELIABILITY OF THE DATA FOR MEMBERS OF THE PAIRS

Groups Compared	Longest sentence	Mean of 5 longest	Mean of all remarks	Number of one-word remarks
Members of Pairs	.35	.42	.51	.66
Halves of Data	.44	.84	.88	.98
Halves of Data [2]	.61	.91	.94	.99

The same comparison was made using the difference between means for members of pairs and for the two halves of the data. In this case 12 sets of unlike-sex twins were included, since inspection of their records had indicated that the same trend is present. The findings are presented in Table VII.

TABLE VII

COMPARISON OF THE MEAN DIFFERENCE BETWEEN MEMBERS OF TWIN PAIRS AND THE MEAN DIFFERENCE BETWEEN THE HALVES OF THE DATA FOR THE INDIVIDUALS MAKING UP SUCH PAIRS

Mean difference between	Longest sentence	Mean of 5 longest	Mean of 50 remarks	Number of one-word remarks
Members of pairs	4.21	2.56	0.88	5.29
Halves of data	3.31	1.88	0.79	1.86
Critical ratio	1.55	1.07	1.07	9.53

In the mean length of all remarks, members of pairs are nearly as much alike as are the two halves of the data. The greatest difference is in the number of one word remarks, which definitely implies that in the use of such remarks members of pairs are very different, while the individual is very consistent.

[1] Goodenough, F. L., and Anderson, J. E. Experimental Child Study. The Century Company, New York, 1931, pp. 239-243.

[2] Corrected by Spearman-Brown prophecy formula.

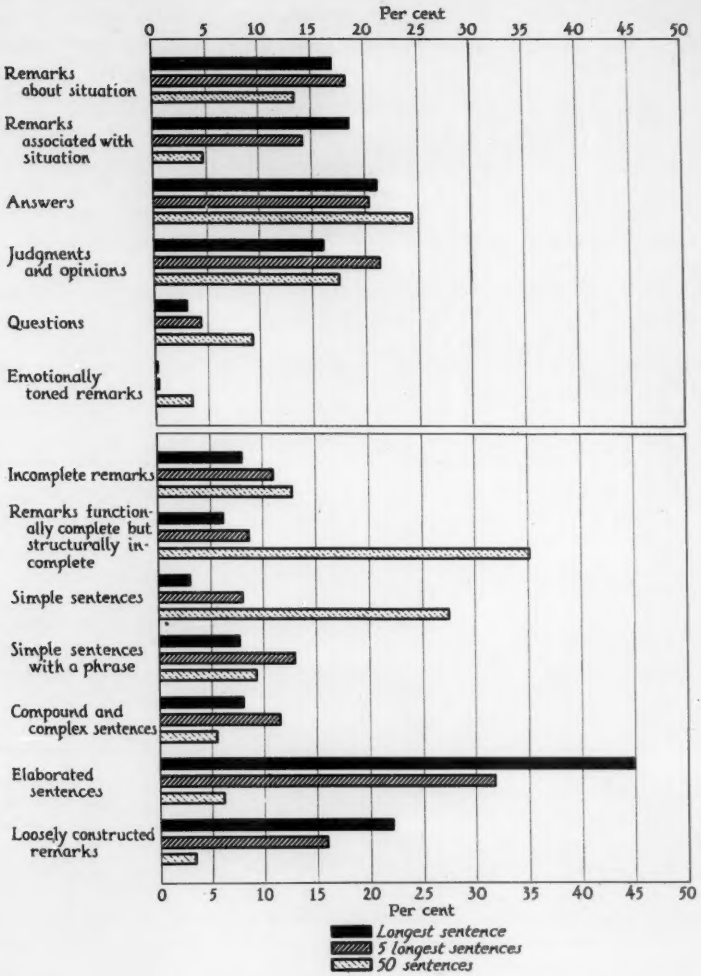

Figure 5. Comparisons of longest, mean of 5 longest, and mean of 50 remarks by functional and structural categories.

Long sentences present certain well-defined characteristics of function and structure which indicate that such sentences do not give an accurate picture of the importance in children's language of certain forms. A large number of functional categories were distinguished in the major study, many of which proved to be of minor importance. Some of these are scarcely represented among the long sentences, and it is only in the larger categories that trends can be considered at all conclusive.

Questions tend to be short. Answers at 9 1/2 years tend to be uniform in length, but at 5 1/2 and 6 1/2 they tend to be short. The greater length at 9 1/2 years may result from school experience, since by the time they reach the fourth grade children have received much training in recitation, and are expected to use complete sentences in replying to the teacher. Remarks about the immediate situation and associated with the situation tend to be long. Opinions and judgments tend to be long at 5 1/2 years, but thereafter they tend to be short. Emotionally toned remarks tend to be very short. These trends are shown in upper half of Figure 5.

In the major study the scheme of classification for sentence structure was roughly as follows:

1. Incomplete remarks.
2. Remarks functionally complete but structurally incomplete. (Many answers, some questions, and many emotionally toned remarks were of this type.)
3. Simple sentences without a phrase.
4. Simple sentences with a phrase.
5. Compound and complex sentences.
6. Elaborated sentences (with two phrases, two clauses, or a phrase and a clause.)
7. Loosely constructed sentences. (These were differentiated because a child frequently corrected himself or interrupted his line of thought midway in a sentence.)

One would expect that compound and complex, elaborated, and loosely constructed sentences would tend to be long and that the others would tend to be short. The lower half of Figure 5 shows that this is strikingly true. However, children do not use a high percentage of highly compounded sentences which simply consist of a number of simple sentences strung together with and, but and or. Table VIII shows that long sentences express much more complicated shades of meaning than do short sentences. Subordinate clauses and infinitives are not only absolutely much more frequent in the long sentences, but also when their occurrence is related to the total number of words making up such sentences. This is even more clearly shown in Table IX by comparing the mean number of subordinate clauses and infinitives in the 5 longest sentences with those in the other 45 sentences.

Further differences between long and short sentences may be distinguished by the type of subordinate clause most frequently used. Table X shows that of all the subordinate clauses used by all the subjects, 39 per cent were found in the 5

TABLE VIII

MEAN NUMBER OF SUBORDINATE CLAUSES AND INFINITIVES PER 100 SENTENCES AND PER 1000 WORDS IN LONGEST, 5 LONGEST, AND 50 SENTENCES

Use of	Age of Subjects	Number of Cases	Mean per 100 Sentences			Mean per 1000 Words		
			Longest	5 Longest	50	Longest	5 Longest	50
Subordinate Clauses	5 1/2	248	54	34	8	40	33	19
	6 1/2	63	43	42	11	26	35	22
	9 1/2	125	102	70	18	51	45	28
Infinitives	5 1/2	248	12	12	3	9	11	7
	6 1/2	63	11	9	4	7	8	8
	9 1/2	125	42	28	10	21	18	15

TABLE IX

MEAN NUMBER OF SUBORDINATE CLAUSES AND INFINITIVES PER CHILD IN THE 5 LONGEST AND IN THE 45 OTHER REMARKS

Age in years	Mean number clauses		Mean number infinitives	
	5 longest	45 other	5 longest	45 other
5 1/2	1.7	2.6	0.58	0.98
6 1/2	2.1	3.6	0.48	1.57
9 1/2	3.5	5.6	1.40	3.39
All	2.3	3.6	0.81	1.76

longest sentences, and 61 per cent in the other 45 sentences. There was a preponderance of noun and adjectival clauses in the 45 sentences, but of adverbial clauses in the long sentences.

TABLE X

PER CENT OF EACH TYPE OF SUBORDINATE CLAUSE FOUND IN 5 LONGEST AND IN 45 OTHER SENTENCES

Per cent in	Noun	Adjectival	Adverbial	All
5 Longest	31.8	37.5	58.8	39.1
45 Others	68.2	62.4	41.2	60.8
Total	100.0	99.9	100.0	99.9

There is some evidence in the literature that indicates that in adult usage the distribution of noun, adjectival, and adverbial clauses is approximately equal. Young children use a high percentage of noun clauses and few adverbial clauses, but as they develop these proportions are reversed, leaving the percentage of adjectival clauses practically unchanged. Table XI shows that the proportion of adjectival clauses is nearly the same in short as in long sentences, but

TABLE XI

PERCENTAGE DISTRIBUTION OF SUBORDINATE CLAUSES IN 5 LONGEST AND 45 OTHER SENTENCES BY TYPE OF CLAUSE

Type of Sentence	Noun		Adjectival		Adverbial		All	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
5 longest	333	33.2	190	18.9	480	47.8	1003	99.9
45 others	714	45.8	316	20.3	529	33.9	1559	100.0

there are more noun clauses and fewer adverbial clauses in short sentences.

Analysis of all the adverbial clauses by type indicates that clauses of time, condition, result, and concession are relatively more frequent in the long sentences, but that the reverse is true of clauses of cause, manner, purpose and place. Clauses of place and concession were so infrequent that only tentative conclusions may be drawn on the basis of the data at hand, but these findings do suggest that long sentences alone would not give a true picture of the relative importance in a child's language of the various types of subordinate clause.

Grammatical errors are more frequent per remark in long sentences, but when the greater length of the long sentences is taken into account the error ratio is found to be slightly less for long sentences. These findings are given in Table XII and XIII.

TABLE XII

MEAN NUMBER OF ERRORS PER 100 SENTENCES AND PER 1000 WORDS IN LONGEST, 5 LONGEST, AND IN 50 SENTENCES

Age in years	Mean per 100 Sentences			Mean per 1000 Words		
	Longest	5 longest	50	Longest	5 longest	50
5 1/2	31	28	14	23	27	32
6 1/2	33	26	13	26	21	24
9 1/2	41	29	14	20	18	22

TABLE XIII

MEAN NUMBER OF ERRORS PER CHILD IN 5 LONGEST AND IN 45 OTHER REMARKS

Age in Years	5 Longest	45 Others
5 1/2	1.39	5.84
6 1/2	1.30	5.14
9 1/2	1.44	5.77
All	1.39	5.72

When a child uses a long sentence he seems to be putting forth his very best effort to express a complicated idea. For this reason long sentences should constitute a valuable measure of maximum ability in the use of language.

SUMMARY

1. Group differences are constant, whether the longest sentence, the mean of 5 longest sentences, or the mean of 50 remarks is employed as the measure of language development.

2. There is a slight positive relationship between length of remark and IQ. The correlation is somewhat greater at 5 1/2 years for the mean of 50 remarks; at 6 1/2 years there is a greater relationship between the longest sentence and IQ; and at 9 1/2 years the relationship is constant for all three measures.

3. The number of one word remarks decreases somewhat with age.

4. There is a slight negative relationship between the number of one word remarks and IQ.

5. Long sentences clearly show development from year to year and are very evenly distributed through the sample of 50 sentences on the basis of odd-even division of the data.

6. All these measures are highly reliable, and the reliability increases with age.

7. The reliability between odd and even remarks of individual members is much greater than the resemblance between like-sex twin pairs.

8. There is reason to believe that the mean of the 5 longest remarks will prove for most purposes fully as satisfactory a measure of language development as the mean of 50 remarks.

9. The use of one-word remarks is very consistent for individual children, but this characteristic probably depends upon other factors than mental development.

10. Long sentences tend to be highly complex, although sometimes rather loosely constructed, and slightly more accurate than are short sentences.

11. In long sentences a large percentage of adverbial clauses are used, and a small percentage of noun clauses. In long sentences adverbial clauses of time and condition are especially important, but in short sentences there is a higher percentage of clauses of manner and cause.

12. The child tends to use long sentences in discussing the situation which engages his attention, or some topic which he associates with the situation.

CORRELATIONS OF PERFORMANCE TESTS WITH OTHER ABILITIES AND TRAITS IN GRADE I

FRANK T. WILSON AND CECILE WHITE FLEMMING[1]

During the school year 1933-34 a variety of tests was given to twenty-five children in Grade I of the Horace Mann School, Teachers College. These included tests of "reading readiness"; many of the Gates Reading Diagnosis tests; some reading achievement tests; mental ability tests, such as the Stanford Revision of the Binet-Simon tests and various performance tests; certain psychological tests, as of perception and perseveration; and several measures of psycho-physical and personality traits and of home background. The purpose of the study was to examine any possible relationships that might exist between measurable traits and abilities, and early progress in the mechanics of reading.

The children of the group came from well-to-do homes. A large percentage of the parents were professional people. The following averages for these pupils were found:

Chronological Age	6.31
Mental Age	7.61
Intelligence Quotient	120.6

Nearly every test and measurement was given or made individually, under carefully controlled conditions, and by reliable persons accustomed to administering tests to young children. The cooperation of the pupils was almost invariably excellent. It is believed for these reasons that errors of examination were unusually low.

This report presents correlations of a battery of "Performance Tests" with about one hundred other measures and appraisals used in the original study. The following performance tests were used:

1 - The Seguin-Witmer-Sylvester Form Board
    Score: Average time, 3 trials
2 - Healy-Fernald, Mare & Foal Test
    Score: (a) Time (b) Errors
3 - Pintner-Patterson, Manikin Test
    Score: Time
4 - Pintner-Patterson, Ship Test
    Score: Standard weighted correct responses
5 - Healy, Picture Completion II
    Score: Standard weighted correct responses

[1] This report presents a minor phase of a study of Reading Readiness and Reading Progress in the Primary Grades of the Horace Mann School, Teachers College, New York, 1933-36. This study has been made possible by the cooperation of Miss Agnes Burke, Teacher of Grade I and other teachers of Kindergarten and Primary Grades. It has been made under the supervision of Doctor Cecile White Flemming, Director of Pupil Individual Development and Guidance, and of Doctor Rollo G. Reynolds, Principal. Prepared by Frank T. Wilson with the assistance of the U.S. Works Progress Administration, New York City, project Number 65-97-295, sub-project 25.

The tests were given according to standardized directions.

The data of the study are in terms of correlations obtained by the rank order method. To secure the rank orders measures and appraisals were reduced to numerical scores. Owing to lack of facilities it was not feasible to make all the computations that were possible in the original study. A "finder" device was used to select for computation the correlations which seemed to promise significance. It is believed that through the use of this device, although it was not altogether accurate, all the high and fairly high correlations were found. The correlations omitted were probably below .50, and most of them probably nearer zero than .50. The P. E. of rho's when N=25, range from ± .0237 for .90 to ±.1335 for .10.

The validity of many of the measures and appraisals is uncertain. Few correlations of seemingly unusual size were obtained, however, and few which were inconsistent with other correlations for the same kind of traits and abilities as found in the complete data of the original study. The opinions of the teacher, of the school psychologist, and of other qualified persons who have studied the figures, are that the results have quite high validity.

II. FINDINGS

Table 1 gives the intercorrelations of the performance tests.

TABLE 1

INTERCORRELATIONS OF PERFORMANCE TESTS

	Mare & Foal Time	Mare & Foal Errors	Manikin	Ship	Healy Picture II
Seguin	.31	-.12	.42	.24	.49
Mare & Foal, Time		.70	.27	.09	.40
" " Errors			.05	.19	.25
Manikin				.08	.56
Ship					.45

Average .298

Mare and Foal time and errors correlated quite high, .70; manikin and Healy II correlated fairly high, .56. The other intercorrelations ranged from .49 to -.12. The low reliability of the measurements, due to the small number of cases and the immaturity of the subjects, may account, in part, for the low correlations. However, the high correlation of Mare and Foal time and error scores, in contrast with the much less significant correlations of Healy II scores with Seguin, Mare and Foal time, manikin, and ship scores, seems to indicate that the tests measure abilities of varied nature as far as these six and seven year old children were concerned.

Table 2 gives the correlations of the performance tests with mental age and

TABLE 2

CORRELATIONS OF PERFORMANCE TESTS WITH BINET M.A. AND I.Q.

	M. A.	I. Q.
Seguin	.32	.10
Mare & Foal, Time	.47	.54
Mare & Foal, Errors	.21	.44
Manikin	.21	.04
Ship	.45	.37
Healy II	.32	.11
Average	.33	.27

intelligence quotient of the Stanford Revision of the Binet-Simon test.

The range of these correlations, from .04 to .54, may be indicative that the performance tests measure abilities which vary from little or no similarity to considerable similarity to the abilities measured by the Binet test.

Table 3 gives correlations of the performance tests with certain other measures.

TABLE 3

CORRELATIONS OF PERFORMANCE TESTS AND CERTAIN OTHER MEASURES

	Other Measures*							
	Information	C. A.	Perseveration	Perception	Tapping	Grip	Vocabulary	Averages
Seguin	.44	.24	-.03	.36	.16	.42	-.11	.21
Mare & Foal, Time	--	-.07	.22	.18	-.07	.01	.04	.05
" " Errors	--	-.24	.27	-.08	-.01	-.16	.00	-.04
Manikin	.39	.24	.42	.35	--	.40	--	.36
Ship	--	.15	-.03	.09	--	--	--	.07
Healy II	.41	.40	.14	.33	--	--	.22	.30
Averages	.41	.12	.17	.21	.03	.17	.04	

*The tests used for the other measures were:

Information: Metropolitan Reading Readiness Tests, Subtest 6

Perseveration: Elkins-Maller Attention Test, Parts II and III

Perception: Exposure of 32 cards, original

Tapping: Whipple-Healy

Grip: Dynamometer, average right and left hands

Vocabulary: Combined scores on Lists 1 and 2 Binet, 20 Action-Agent words, 25 words from the Iowa Kindergarten Vocabulary Tests.

These coefficients are not high and the variability is large. The information test gave the most consistently high correlations with the battery, averaging .41 for three correlations. The manikin test gave the most consistently high correlations with the seven measures, averaging .36 for five correlations.

Tables 4-8 give the computed correlations of the performance tests with groupings of tests and appraisals of reading, letter abilities, mental abilities, psycho-physical and personality traits.

TABLE 4

CORRELATIONS OF PERFORMANCE TESTS WITH MEASURES OF READING ABILITY

	Seguin	Mare & Foal Time	Mare & Foal Errors	Manikin	Ship	Healy II	Average
Gates Primary Reading Tests, Type 2, Sentence Reading, March		.57				.52	.55
Gates Primary Reading Tests, Type 3, Paragraph Reading, March		.45			.38	.50	.44
Hildreth, First Grade Reading Analysis Test, Matching Words		.38					.38
Hildreth, First Grade Reading Analysis Test, Matching words and phrases in sentences		.48				.43	.46
Teacher's Ranking in Reading, November prediction	.21	.43	.00	.17	.25	.44	.25
Teacher's Ranking in Reading, May ability	.19	.42	.03	.19	.18	.47	.25
Gates Primary Reading Tests, Type 1, Word Recognition, May	.10	.57	.26				.31
Gates Primary Reading Tests, Type 2, Sentence Reading, May	.09	.41	.00			.44	.24
Gates Primary Reading Tests, Type 3, Paragraph Reading, May	.10	.52	.18	.15	.09	.36	.23
Averages	.14	.47	.094	.17	.23	.45	.346

Table 4 shows the correlations of the performance tests with reading tests. These results have particular significance because the 91 intercorrelations of the 14 reading measures of the original study averaged .73. The Mare and Foal time test and the Healy Picture Completion II gave the highest averages, .47 and .45, as shown in Table 4. The variability of the separate correlations of these

two tests with the reading tests was not very great, ranging from .38 to .57 for the Mare & Foal, time, and from .36 to .52 for the Healy. All the other computed correlations of the table were low and, considering the large probable errors, indicate little, if any, significant relationship between the reading and the mental or other abilities involved in those performance tests. Even in regard to the Mare and Foal and the Healy tests it seems that the abilities involved were not closely related to the reading abilities tested.

TABLE 5

CORRELATIONS OF PERFORMANCE TESTS WITH MEASURES OF ABILITY WITH LETTERS

	Seguin	Mare & Foal Time	Mare & Foal Errors	Manikin	Ship	Healy II	Average
Van Wagenan Reading Readiness Test, Word Discrimination	.32					.33	.33
*G. R. D. T. VIII, 2, Word Recognition - Visual Presentation	-.08	.40					.16
*G. R. D. T. VIII, 3, Word Recognition - Auditory Presentation	.13	.32					.23
*G. R. D. T. IX, 1-7, Giving Phonic Combinations	.16	.19					.18
*G. R. D. T. IX, 9, Giving Letter Sounds	.31	.39					.35
*G. R. D. T. X, 1, Blend Sounds	.34	.15	.24		.49		.31
*G. R. D. T. X, 2, Recognition Sounded Letters	.23	.02	-.10				.05
*G. R. D. T. X, 3-4, Giving Initial and Final Sounds	-.19	.33					.07
*G. R. D. T. XIII, 1-2, Write Words	.11	.20					.16
*G. R. D. T. IX, 10, Recognition Capital Letters	.22	.36					.29
*G. R. D. T. IX, 11, Recognition Small Letters	.07	.40					.24
*G. R. D. T. XV, 2, Memory Span, Letters	.36	.66	.41		.27		.45
*G. R. D. T. XIII, 3, Adapted, Writing Capital and Small Letters and Digits	.43	.55	.23				.40
Averages	.19	.331	.195		.38	.33	.246

*Gates Reading Diagnosis Tests

Table 5 is for the correlations of the performance tests with letter abilities. Most of the coefficients in this group are for the Seguin and the Mare and Foal time measures. The "finder device" indicated that nearly all the coefficients

for the other performance tests and letter abilities would be very low, and so they were not computed. The averages of 13 correlations of Seguin with letter tests was .19; that of twelve correlations of Mare and Foal time with letter tests was .33. The large variability in the size of the correlations seems reasonable when the strikingly different abilities of the letter tests are noted. For example, writing letters is quite different from giving phonic combinations or words beginning or ending with the same sounds. The figures show little, if any, significant relationship between performance tests and letter abilities.

TABLE 6

CORRELATIONS OF PERFORMANCE TESTS WITH MEASURES OF MENTAL ABILITY

	Seguin	Mare & Foal Time	Mare & Foal Errors	Mani-kin	Ship	Healy II	Average
Van Wagenan Reading Readiness Test, Information	.59					.53	.56
Van Wagenan Reading Readiness Test, Relations					.43		.43
*H., G. O. M., T. Sentences			.24				.24
*H., G. O. M., T. Numbers	.43					.31	.37
*H., G. O. M., T. Information	.44			.39		.41	.41
*H., G. O. M., T. Total	.45	.40			.41	.49	.44
*H., G. O. M., T. Drawing Man		.40	.60			.46	.49
Vocabulary, Total	-.11	.04	.00			.22	.04
Mental Age, Stanford Revision of the Binet-Simon Test	.33	.47	.21	.21	.45	.32	.33
Intelligence Quotient, Stanford Revision of the Binet-Simon Test	.10	.54	.44	.04	.37	.11	.27
Gates Reading Diagnosis Tests, Total XV, 1-4, Memory Span, Total	.34	.68	.42				.48
Averages	.32	.42	.32	.21	.42	.36	.369

*Hildreth, Griffith, Orleans Metropolitan, Readiness Test for Kindergarten and Grade I, ---

Table 6 gives correlations of the performance tests with other measures commonly held to be those of mental abilities. These correlations were a little higher than those for reading and letter abilities, as might be expected, but the averages for the several performance tests were not high, varying from .21 to .42. The Mare and Foal time and the ship tests gave higher correlations with Binet mental age and intelligence quotient than any of the others, although the probable errors of the correlations make the differences meaningless. Comparison of the two correlations of the intelligence quotient with the Mare and Foal and the Healy test is quite striking, .54 as compared with .11. The correlations of these two performance tests with mental age were much more similar, .47 and .32 respectively.

TABLE 7

CORRELATIONS OF PERFORMANCE TESTS WITH PSYCHO-PHYSICAL MEASURES

	Seguin	Mare & Foal Time	Mare & Foal Errors	Manikin	Ship	Healy II	Average
Gates Reading Diagnosis Tests, XIII, 3, Adapted, Writing Capital and Small Letters and Digits, Time	.08	-.00		.02			.03
Vocabulary Time	.26	.13		.01			.13
Perception	.36	.18	-.08	.35	.09	.33	.21
Steadiness (hole apparatus)				.39			.39
Tapping, Whipple and Healy	.16	-.07	-.01				.03
Perseveration, Elkins and Maller Attention Test		.22	.27	.42	-.03	.14	.17
Chronological Age	-.03	-.07	-.24	.24	.15	.40	.12
Grip	.24	.01	-.16	.40			.17
Motor Coordination (Battery of six tests)	.42						
Weight	.35			.54			.45
Height	.17	-.07	-.20				-.03
Nutrition (variation from height-weight-age norms)	.27	-.06	-.00				.07
Developmental Index (Babyhood)	-.07	-.08	-.21				-.12
	.26	.05			.13	.24	.17
Averages	.21	.02	-.08	.30	.09	.28	.138

TABLE 8

CORRELATIONS OF PERFORMANCE TESTS WITH PERSONALITY MEASURES

	Seguin	Mare & Foal Time	Mare & Foal Errors	Manikin	Ship	Healy II	Average
Reversals, Visual Perception (letters, digits, words, numbers)	.24	.24	.22	-.15	.14	.07	.13
Reversals, Auditory Perception (letters, digits, words, numbers)	.20	.15	.05	.15	-.13	-.10	.05
Undesirable Behavior and Traits	.36	.08			-.34	.07	.04
Personal Traits	-.04	.21			-.46	-.03	-.08
Personality Rating, Hicks, A Personality Rating Scale for Children Six to Nine	.23	.24			-.43	.19	.06
Averages	.20	.184	.14	.00	-.25	.04	.04

TABLE 9

FREQUENCIES OF CORRELATIONS OF TABLES 4-8

Performance Tests with

Range	Reading	Letters	Mental	Psycho-Phys.	Pers'y.
.60 to .69			2		
.50 " .59	5	2	3	1	
.40 " .49	9	5	14	4	
.30 " .39	3	10	6	5	1
.20 " .29	3	5	4	8	7
.10 " .19	8	5	2	7	4
.00 " .09	5	2	3	6	4
-.00 " -.09		1	0	12	2
-.10 " -.19		2	1	1	3
-.20 " -.29				3	0
-.30 " -.39					1
-.40 " -.49					2
Number	33	32	35	47	24
Averages	.304	.269	.364	.127	.049
S. D. Distribution	±.176	±.168	±.175	±.200	±.224

Table 7 gives the correlations of the performance tests with psycho-physical measures. The coefficients are low as might be expected. The averages for the six various performance tests ranged from -.08 to .30.

Table 8 shows that the averages of the correlations of the performance tests with measures of personality were the lowest of all the groups, ranging from -.25 to +.20. The three fairly high negative correlations of the ship test, with personal traits, -.46; with personality rating, -.43; and with (few) undesirable traits, -.34, seem peculiar, as no such tendency appeared with any of the other performance tests. In fact, the opposite tendency is indicated by .36, the correlation for the Seguin Form Board with (few) undesirable traits, .24, for Mare and Foal time with personality rating; and .23, for Seguin with personality rating. It seems improbable that even such moderate negative relationships as shown by the figures for the ship test should be the rule.

Table 9, gives, for convenience, the frequencies, averages, and standard deviations of the computed correlations of all the performance tests and the other measures by the groupings shown in Tables 4-8. This table seems to indicate that the performance tests were somewhat related to abilities. A slight relationship with psycho-physical abilities may have been present. In general, no relationship of consequence appeared between the performance tests and the personality measures used.

CONCLUSIONS

It would seem that the small degree of relationship shown by the coefficients of correlation reflects, in general, the true relationships between such abilities in the organization of young children's natures. The tendency toward low correlations as found in this study is in accord with the present theories of the relatively unintegrated nature of abilities and traits of young children, as proposed, for example, by Hartshorne and May in their study of Organization of Character and by Miss Shirley in her three year study of infants. If this fact be true for such children as those tested in this investigation it raises the problem in first grade teaching of the nature of the guidance to be given by the teacher. Reports of other studies, and of other phases of the Horace Mann School study of which this is a part, indicate that the guidance which recognizes the particular and individual nature of maturing abilities and maturing organization promises the greatest good in both learning and personality development. In other words, teaching of young children which is characterized by insight into the nature and needs of each child, is better than teaching according to a system or to a fixed course of study.

A COMPARISON OF FOUR CURRENT METHODS OF ESTIMATING PHYSICAL STATUS

EVERETT L. MARSHALL [1]

A study showing the extent to which over- and under-weight occurred for 77 boys according to the Baldwin-Wood age-height-weight table, the Pryor and Stoltz age-hip-height-weight standards, the Franzen and Palmer ACH Index, and the McCloy age-height-hip-chest-knee-weight standards.

INTRODUCTION

An unusual interest in child development together with the desire to be able to appraise the physical status of the individual has led to the development of several anthropometric techniques for this purpose. The oldest and most widely known of these anthropometric standards is the Baldwin-Wood age-height-weight table[2] which was published in 1925 (1). As may be inferred from the title, this table estimates the normal weight for the individual, given his age and height.

In 1933, Pryor and Stoltz (4) reported a method of estimating normal weights which is a variation of the Baldwin-Wood table. In addition to height, the bi-iliac width of the hips is employed to ascertain the normal weight of an individual of a given age and sex.

The ACH Index of nutritional status, devised by Franzen and Palmer (2), appeared in 1934. This index was derived to enable school health workers to select from a given group of school children those individuals who are underweight and probably in need of medical or nutritional attention. It functions in the following manner. If for any individual between 7 and 12 years of age the difference between the sum of two arm girths (one with arm flexed and the other with arm extended) and the sum of two chest depths (inspiration and expiration) is less than a certain amount for a given age and hip-width (bitrochanteric), the individual is estimated as being underweight. Those indicated as underweight by the ACH Index (about 10 per cent of a representative group of American school children) are given a more thorough examination and according to the originators of the technique, more than 80 per cent of those given the intensive examination are either "extreme defect cases or border line cases." Franzen and Palmer note that some cases of marked "underweight condition" are missed by the ACH Index but claim that the number here is comparatively few.

In common with all the standards thus far discussed, those developed by Professor C. H. McCloy (3) of the Iowa Child Welfare Research Station estimate the normal weight of an individual by first taking age and sex into account. The tables, specific for age and sex, have been compiled by the use of multiple regression equations. The normal weight for an individual - given his height, hip width (bi-iliac), chest circumference, and knee width - is readily obtained by the use of these tables.

[1] From Department of Psychology, Illinois State Normal University, Normal, Illinois.

[2] The first weight-height-age table created by Wood appeared as early as 1910.

The purpose of this study is to apply each of these four techniques to a group of boys and to compare the results. No attempt is made to claim superiority for any of the procedures.

SUBJECTS

The subjects for this investigation were 77 boys between 7 and 12 years of age who were in attendance at the University of Iowa elementary school during the spring of 1935. All measurements needed to employ each of the four techniques were taken at one measurement period.

PROCEDURE

The physical status of the 77 subjects was estimated by each of the four techniques. The ACH Index does not yield ratings that may be converted into given per cents of over- or underweight but merely indicates those individuals who are suspected of being underweight. In the case of the three other methods, the individual's normal weight is estimated and per cents, such as those presented in the following table, are found by dividing the actual weight of each individual by his estimated weight.

TABLE I

TABLE SHOWING THE RESULTS OBTAINED BY EACH OF FOUR METHODS OF ESTIMATING PHYSICAL STATUS

Per cent of normal weight	Baldwin-Wood		Pryor & Stoltz		C. H. McCloy		ACH Index	
	No. of cases	Per cent	No. of cases	Per cent	No. of cases	Per cent	No. of cases	Per cent
151-175	2	3						
126-150	3	4	3	4				
116-125	3	4	1	1	1	1		
96-115	51	66	17	22	58	75		
86- 95	16	20	34	43	18	23	Underweight	
70- 85	2	3	22	29			4	5
Range	85-172		71-143		89-123			

The zone of normal weight is considered to extend from 96 to 115 per cent. Thus 66 per cent of the boys fall within the normal zone by the Baldwin-Wood table, 22 per cent within the normal zone by the Pryor and Stoltz standards, and 75 per cent within the normal zone by the McCloy tables. It is further obvious from Table I that the per cents "underweight" by each of the four methods under consideration present notable disagreement. This disagreement is analysed in greater detail in Table II, where the overlapping and lack of correspondence of the underweight cases[1] for each method is shown.

[1] "Underweight cases" are all those cases whose actual weight is 95 per cent or less, of their weight, as estimated by any of the four methods under consideration.

TABLE II

Table showing the overlapping and disagreement in underweight cases. In the first column is given the number of cases underweight according to each method. The other columns show where the cases which are estimated underweight by a given method are placed by each of the other methods, i.e., whether they are considered underweight, normal or overweight.

Underweight cases	Baldwin-Wood			Pryor & Stoltz			McCloy			ACH Index		Pryor & Stoltz(a)*
	U	N	O	U	N	O	U	N	O	U	N-O	U
Baldwin-Wood 18	18			18			11	7		2	16	10
Pryor & Stoltz 56	18	38		56			18	38		3	53	22
McCloy 18	11	7		18			18			3	15	6
ACH Index 4	2	2		3	1		3	1		4		3
Pryor & Stoltz(a)*22	10	12		22			6	16		3	19	22

*The 22 cases in this group weighed less than 86 per cent of their estimated weight according to the Pryor and Stoltz standards. Note that only 10 of the 18 underweight cases according to the Baldwin-Wood table are in this lowest group for the Pryor and Stoltz standards, etc.

Some of the important points derived from Table II are:

1. Of the 18 subjects who are underweight according to the Baldwin-Wood table, all are in that category on the full Pryor and Stoltz standards but only 11 and 2 are estimated underweight by the McCloy tables and the ACH Index, respectively.

2. Of the 56 cases found underweight by the Pryor and Stoltz standards 18 are underweight according to both the Baldwin-Wood and McCloy tables yet only 3 (less than 6 per cent) are underweight by the ACH Index.

3. Of the 22 cases below 86 per cent on the Pryor and Stoltz standards 12 cases are in the normal group on the Baldwin-Wood table, while 16 and 19, respectively, are in that class according to the McCloy tables and the ACH Index.

4. As on the Baldwin-Wood table, 18 subjects are underweight by the McCloy standards. Only 11 of these subjects, however, are the same for both groupings. Of the 18 underweight cases by the McCloy standards as few as 3 (one-sixth) are in that group according to the ACH Index.

5. One of the 4 cases designated as underweight by the ACH Index is in the normal group according to the McCloy and the Pryor and Stoltz methods, while two of these 4 cases are estimated as normal by the Baldwin-Wood table.

It appears from the preceding tables that the Baldwin-Wood table and the McCloy standards yield somewhat similar results. However, there are several extreme cases in the former distribution which are not present in the latter. Two subjects have per cents above 150 on the Baldwin-Wood table but on the McCloy standards these are 115 and 123, respectively, while the Pryor and Stoltz standards place them at 132 and 143. The results procured by the ACH Index and the Pryor and Stoltz standards disagree markedly. The former method indicates that only 5 per cent of the cases are below normal while 72 per cent are in that category according to the latter. The Baldwin-Wood table and the McCloy standards each indicate that 23 per cent of the cases are in the underweight group. No obvious causes of the varied results were apparent and re-checking of findings yielded none.

The mean for each age on the McCloy tables was compared with corresponding means on the Pryor and Stoltz standards in search of a possible explanation of the diverse results but the differences were found to be negligible.

SUMMARY

Four methods of estimating physical status: the Baldwin-Wood age-height-weight table, the Pryor and Stoltz age-hip-height-weight standards, the Franzen and Palmer ACH Index, and the McCloy age-height-hip-chest-knee-weight standards were employed on 77 subjects.

The results obtained by the application of the Baldwin-Wood tables and the McCloy standards were similar but those secured by the Pryor and Stoltz standards and the ACH Index were heterogeneous.

There was considerable lack of agreement found, i.e., the subjects with a low per cent according to one method were frequently in the normal zone according to another method.

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THE EFFECT OF THUMB AND FINGER SUCKING ON THE PRIMARY TEETH AND DENTAL ARCHES [1]

SAMUEL J. LEWIS [2]

Several fundamental questions may be asked about this matter of the effect of thumb and finger sucking on the primary teeth and dental arches. For example, do these habits cause deformities? If so, do they cause a specific type of deformity? How early may it be observed? Do all thumb and finger suckers produce deformities? Is there any relation between the manner in which the thumb is sucked and the presence or absence of deformity? Are there any established facts to prove that thumb or finger sucking causes deformities? What happens when the habit presists, and what happens when it is broken? Are mechanical appliances such as the orthodontist uses indicated to correct such deformities in the primary dentition?

With these and other questions in mind, I started in 1924 a systematic study of the growth and development of the teeth and dental arches of the Merrill-Palmer nursery school children. My method was to make yearly records of their dental conditions, including impressions of their teeth and dental arches from which models were made. These individual series of models, together with the many concurrent data on other aspects of growth and development taken at the school, gave me a tangible record of the localized changes incident to dental growth and development from which many studies could be made.

In 1929 I began a survey of the conditions of the occlusion of the teeth, and among other things noted a certain similarity in the type of dental arches of a number of the children. The models of these children were segregated for study and their histories examined. In each case there was a definite history of thumb sucking at sometime or another in the life of the child. I then looked over the models of the other children to see if I could find other types of occlusion associated with this habit. I succeeded in finding six cases of children who had histories of sucking the thumb but who presented no deformities. These were laid aside for further study.

From a study of the histories of these cases, thirty in all, I learned that all but two had started to suck their thumbs during the nursing period, and that twenty one had been broken of the habit between the first and the sixth year of age. Eight were still sucking their thumbs. On one we could get no report.

What was the result of this study? Figure 1 shows the type of thumb sucking that did the most damage to the shape of the arch. Here you will note that the thumb is sucked with the volar surface toward the palate. There is considerable pressure exerted on the teeth and the premaxillary bone, which until the child is seven years old is likely to have its sutures still open. Recent experiments have

[1] From report presented at Symposium on Primary Teeth held at Second Biennial Meeting of the Society for Research in Child Development in Washington, October, 1936.

[2] From Detroit, Michigan.

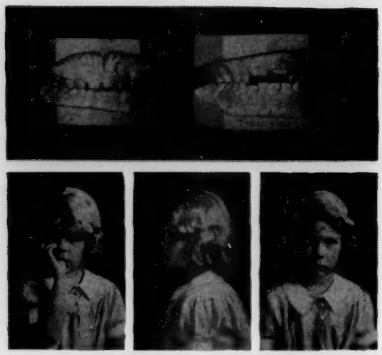

Figure 1. Type of thumb sucking which causes the most damage. Note the volar surface towards the palate.

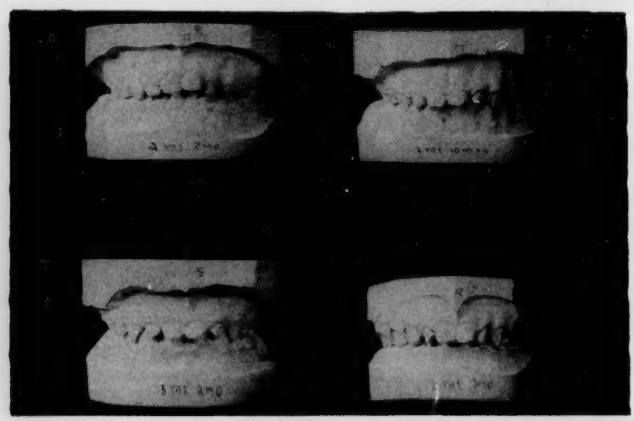

Figure 2. Types of deformities of the dental arches caused by thumb sucking.

shown that four ounces of pressure from a wire spring of but .020" in diameter are sufficient to move a tooth in the surrounding bone. The pressure from the thumb is manyfold greater than this.

Figure 2 shows the types of deformities caused by thumb sucking. The deformity is characterized by a forward displacement of the upper front teeth and sometimes a retrusion of the lower teeth. If the right thumb is sucked the displacement is towards the right; if the left, towards the left; and if both thumbs are sucked the displacement is symmetrically forward.

But in these cases all the primary teeth were in place. They did not tell me how early the deformity appeared or whether it was perceptible before the primary teeth were erupted. In 1930 I examined a group of babies in one of our hospitals, making casts of their toothless jaws when they were as young as one month of age. Figure 3 shows the normal shape of a baby's dental arches. They are round and more or less symmetrical. Figure 4 shows some of the palates of babies who sucked their thumbs. You will notice the deflections caused by the sucking habit.

During the course of my study I received a letter from Dr. Henry Klein, who was at that time working with Dr. E. V. McCollum at Johns Hopkins University. He wrote that he had under observation a monkey which had been sucking its fingers for three years, and which presented a deformity very much like that seen in children. Figure 5 shows the deformity, and you can see for yourself that this is no monkey-shine. The motion picture of this monkey shows that he sucked the fingers with the volar surface towards the palate.

Having satisfied myself that thumb sucking could produce a deformity of the primary teeth, I began to study successive models of our cases to see what happened at later periods. Figure 6 illustrates a case where the habit persisted until three years of age and was then broken. A full correction of the deformity took place within a year and a half. Note in the first model to the left that the lower anterior teeth retrude. This seems to happen when the thumb is pushed against the upper teeth and the lower teeth are used as a sort of fulcrum. This case represents one of self correction, or perhaps better still, a spontaneous correction by nature due to the breaking of the habit.

What happens if these children resume the habit after it has been broken and a self correction has taken place? The child whose models are shown in Figure 7 was broken of the habit and there followed the usual self correction of the deformity. Later, however, during a serious illness, she again took up the habit, with the result that the permanent teeth were pushed out of position just as the primary ones were.

I found further that in children who had a deformity coexistent with the habit and who persisted in sucking their thumbs, even for a short time before going to sleep, there was no self correction of the deformity, which either remained the same or became progressively worse. Figure 8 illustrates one of that type. The child was still sucking his thumb when the last model was made.

Figure 9 shows an interesting case. The right thumb was sucked producing,

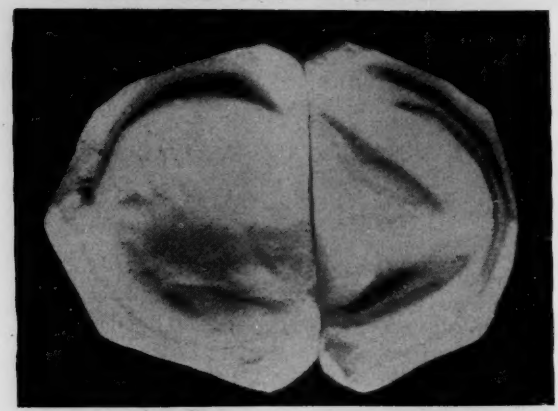

Figure 3. Normal shape of a baby's dental arches.

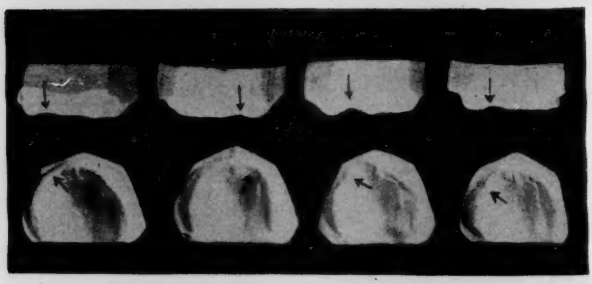

Figure 4. Palates of babies who sucked their thumbs. Note the deviation from the symmetry seen in Figure 3

Figure 5. A Macacus Rhesus monkey who sucked his fingers. Note the similarity of the deformity to that of the child shown in Figure 8.

Figure 6. Showing a case of self correction of the deformity caused by thumb sucking following the breaking of the habit at 4 years of age.

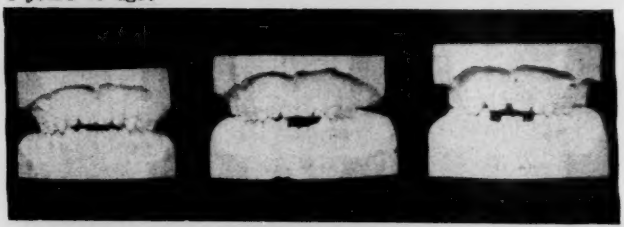

Figure 7. A case of self correction of the thumb sucking deformity followed by the reappearance of the deformity after the habit was resumed.

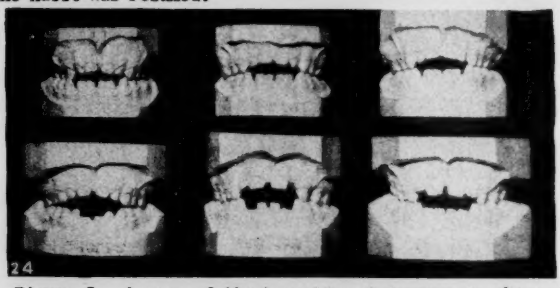

Figure 8. A case of thumb sucking deformity in which the habit was not broken. The deformity still exists in the permanent dentition.

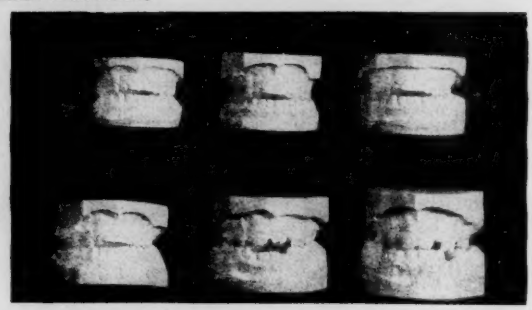

Figure 9. Deformity caused by sucking the right thumb. Besides the anterior protrusion there was an open bite. After the habit was broken at 9½ years, both the protrusion and the open bite corrected themselves.

besides the displacement, what is called an open bite. The habit persisted until the boy was about nine years old, when he was shamed by his schoolmates into breaking it. The last model on the right in the lower row shows what happened to his occlusion. There has been a definite improvement, and had he not gotten into the hands of an orthodontist who knew nothing of the history of the case, I believe that his occlusion would have been normal without the use of appliances.

I know that you must by now be thinking of what happened to those six cases where there was thumb sucking but no deformity. Their histories show that all six were broken of the habit sometime between the first and second year of age, or sometime before they entered the nursery school. In the light of my discoveries concerning the relation between thumb sucking and deformity of the primary dental arches, I was satisfied that either the deformity corrected itself before I saw the children, or that they sucked the thumb in other ways than with the volar surface toward the palate. This I cannot prove, but it seems to me a logical conclusion. Now, then, what are we to do in the way of treatment? Should we correct these cases through the medium of orthodontic appliances, or should we attempt to break the habit and wait for results? Where the primary teeth are involved, the latter procedure seems to be the better one. While I have seen self-corrections as late as the tenth or eleventh year of age, they do not always occur even if the habit has been broken. Some of these cases can be broken of the habit only by correcting the deformity through the medium of appliances such as the orthodontist uses. A new environmental condition is then produced and the thumb, having no longer the place to rest that it had before the deformity was corrected, ceases to find its way to the mouth. Figure 10 illustrates such a case. This child sucked the forefinger with the volar surface towards the palate and the habit had persisted since she was a baby. Note the type of deformity that was produced. All methods of breaking the habit failed until the deformity was corrected with orthodontic appliances. The correction was followed by a complete cure of the habit, and the teeth "Stayed put." The child told me later, "I can now smile without having to hold my hand over my mouth."

Figure 10. A case where the right forefinger was sucked from infancy with the volar surface towards the palate. The habit was finally broken by treating the malocclusion with orthodontic appliances.

THUMB OR FINGERSUCKING FROM THE PSYCHIATRIC ANGLE [1]

DAVID M. LEVY [2]

Previous observations and clinical studies have demonstrated that the primary cause of fingersucking is insufficient sucking at breast or bottle. This was determined first by a study of numerous feeding histories. In the case of families in which some children had the sucking habit and the others were free of it, it could always be shown that the former had less sucking activity than the latter. It was shown also that when the habit started after the first few weeks of life it was definitely related to a diminution of sucking-time. In the case of children whose sucking started after birth, though in the first week of life, it was shown that there was a diminution of sucking-time because of the rapidity of the flow of milk from breast or bottle. Statistical evidence demonstrated that the percentage of fingersucking problems is also consistent with the sucking-time, rising as high as 40 per cent in infants fed at four-hour intervals to as low as 6 per cent in unscheduled feeders. The conclusion that sucking-time is the primary factor in the etiology of fingersucking was aided by the following observations. There was not one instance of fingersucking in the case of children who used pacifiers. In several cases of children with rickets, whose feeding histories showed sufficient sucking-time, the habit did not develop, thus ruling out the nutritional factor as a primary cause. In an experiment with an infant of 8 months, whose thumbsucking started when feeding from a glass was substituted for one bottle feeding, the sucking was stopped by a return to the bottle and started again by a return to the glass. In another case, an infant of 6 months, who sucked his finger immediately after each bottle feeding, it was demonstrated that by using a nipple with a fine hole, increasing the sucking-time to 25 minutes, the finger did not go to the mouth after the feeding.

Further proof was added from observations and experiments with animals. The calves of dairy cows show a marked contrast with the calves of beef cows, in that the former develop various licking habits which do not occur in the latter. The calves of dairy cows, unlike the others, do not suck from the udder but are fed from a bucket and hence do not satisfy their normal sucking needs.

An experiment was made of four pups in a litter in which the sucking-time could be accurately determined. The two pups with diminished sucking-time developed perverted sucking, in the form of sucking their own bodies or straw or towels, or sucking each other's bodies. In the experiment all other conditions, including nutrition, were constant.

Studies in the pecking activity of chickens demonstrated a similar principle, namely, that the energy generating instinctive behavior of the pecking type is far in excess of the requirements of nutrition; as also in sucking, and also, for example, in sexual activity, in which the sexual impulses are far in excess of

[1] Abstracted from paper presented at Symposium on Primary Teeth held at Second Biennial Meeting of the Society for Research in Child Development in Washington, October, 1936.

[2] From New York City.

the needs of procreation. 200 ten-day-old chicks were divided in two groups. Both were brought up under the same conditions of food, light, indoor and outdoor space. The experimental group was raised about two inches from the ground by means of a half-inch wire mesh. Within five weeks the chicks on the wire showed in every instance patches of denudation where they had pecked off the feathers. In contrast, the control group showed but two instances of denudation, of a minimal degree. The difference was due obviously to the fact that the needs of pecking were inadequately released on the wire.

The discrepancy between sucking needs for the purpose of nutrition and sucking needs as a pleasurable activity was recognized by Freud. It was on the basis of this observation, namely, a cleavage between the pleasurable and nutritional phases of the feeding act, that he developed the theory of erogenic zones. These represent areas of tension in the body relieved with pleasurable sensation.

In the case of thumbsucking and in other forms of sucking habits, there is often a movement of the other hand that accompanies the sucking act. This movement has been called an accessory movement and has been traced to movements that were made by the free or locked hand while at the breast or bottle. Such movements may become so integrated in the pattern of the sucking act that the sucking cannot continue without them. For example, consider the case of a child whose accessory movements while thumbsucking were holding of an object. When the object was removed, the thumb left the mouth. Cases have been observed also in which initiation by the observer of the accessory movements was followed immediately by thumbsucking. For example, a child whose accessory movement was feeling its hair could be started sucking when the observer felt its hair. In the case of a child who sucked its thumb only while feeling silk, the very specific accessory movement was traced to movements of the finger on a silk wrapper which the mother always wore when she fed at the breast.

So-called accessory movements often occur without thumbsucking. A number have been traced to movements while feeding at the breast or bottle, without the development of sucking habits. Such movements have been thought to derive their "strength" from their original association with a pleasurable feeling during the sucking act; for example, hair stroking, hair pulling, pinching of skin, rotary movements of finger tips or of the hands. Another source of such movements is the concealing or masked movement. In thumbsucking, such movements arise to conceal the sucking act, usually by bringing the palm of one hand over the sucked hand. More frequent is the attempt to conceal a deformity to which the child has been made sensitive, such as scars, etc., especially crooked teeth. These movements may be of tremendous consequence. They involve various finger play to the teeth or mouth, or laughing with the palm over the lips, but probably become more important as an actual limitation of the excursion of the lips in smiling or talking, in order to conceal the crooked teeth (often a result of fingersucking). The latter activity would aid not only in offsetting spontaneous conversation, introducing a consistent self-conscious factor into social relationships, but in increasing the amount of lip tension and hence, theoretically, increase the erogenicity of the oral zone.

Such movements also result from the attempt to modify undesirable movements and

are hence modifications of them. For example, nail biting is often a modification of thumbsucking. Other modified movements in the case of thumbsucking are running the finger tips over the lip area, lip sucking or biting, merely keeping the fingers to the lips, finger restlessness, constant tweaking of the fingers, running one finger tip under the other, etc.

Psychoanalytic investigations have traced the formation of certain personality traits to erogenic zones. Out of this a characterology has arisen by which physiologic behavior becomes translated into social behavior. A prolonged fingersucking, involving, as it does, retention of the finger in the mouth for long periods of time, would become correlated with retention in the psychological sense, or hoarding. The activity of getting objects to put in the mouth would become correlated with enterprise, or with grasping in the psychological sense. In relation to the mouth area, these "character formations" are still speculative inferences. In regard to the anal zone, however, such correlations have a more convincing body of clinical evidence to support them.

In general, psychiatric advice as to the fingersucking habit has been to ignore it. Such advice has been given on the basis that the child evidently needs the sucking it derives in this manner, and, if it does no harm, there is no reason to interfere with it. When there is no question that it is harmful, psychiatrists have generally been at a loss as to methods of dealing with it. The harm occurs in those cases in which the absorption in the act is sufficiently great to prevent normal interest in other activities, in some cases even to ordinary learning. Besides the harm of excessive sucking, there is the danger of malformation of the jaws, especially the overbiting and spacing of the upper incisors due to the pressure of the volar surface of the thumb against them. Malformation of the palate, also, has been traced to sucking. The problem of malformation due to thumbsucking has been pretty well settled by the work of S. J. Lewis. Ordinary observation of the type of sucking that the child employs will easily determine whether a malformation is likely.

In regard to advice as to the prevention of the act, psychiatrists seem to be puzzled like everyone else. Their hope is generally that the sucking habit will stop once the emotional difficulties of the child are solved, since, as is well known, a fingersucking child will utilize the habit especially when it is in a state of emotional tension. Appeals have been made directly to the child to stop the habit, by boosting his ego, by explanation of the possible harmfulness of the act, etc. Since such methods are often unsuccessful, recourse has been sought to the old inhibitory devices of mechanical restraints and bitter tasting chemicals on the finger tips. Rationally, according to the studies described, the prophylactic and also the direct therapeutic device in infancy consists in a return to the use of the pacifier. The arguments against its use are based either on inferences about the pacifier as a source of infection, which has not been proven, or on certain abuses of it, which are no longer necessary. Methods in older children must be combined with various types of activity that release tension of lips and fingers.

THE EFFECT OF NUTRITION ON THE PRIMARY TEETH [1]

FREDERICK F. TISDALL [2]

The deciduous teeth begin to calcify about the fifth month in utero, calcification of the crowns being completed towards the end of the first year of life, and the roots during the third year of life. It is therefore evident that the diet of the child during the first three years of life can affect the nutrition of the deciduous teeth during their period of calcification.

Dr. Martha M. Eliot and her co-workers (1) examined the teeth of children who had been examined some years before for the presence or absence of rickets. This examination showed a definite relation between hypoplastic defects of the enamel of permanent teeth and rickets. In regard to the deciduous teeth, Dr. Eliot found there was a slight preponderance in the incidence of hypoplastic defects of the enamel in the children who had had severe rickets. In a discussion of this paper, Dr. Alfred Hess stated that he had found many more cavities in the teeth of children with rickets in infancy than in those who had been protected against rickets.

A study on the effect of nutrition in relation to tooth decay has been made in Toronto and reported by Anderson et al (2). In planning this investigation a survey was made of the supply of the various dietary factors necessary for normal nutrition. It was found that even under excellent dietary and hygienic conditions the average Canadian child does not receive any vitamin D for many months of the year unless it is specifically administered. The vitamin D value of sunshine in Toronto takes a very marked drop about the 15th of October and remains at an extremely low level throughout the winter months (3). This combined with the necessity for bundling up the child means that very little vitamin D effect is obtained from sunshine in Canada and the Northern part of the United States from the middle of October until the middle of April, which is approximately one-half of each year. A study of the vitamin D content of ordinary foods (4) has shown that it would require 890 servings of spinach, 1560 servings of beets, or 4000 servings of lettuce to furnish the vitamin D equivalent of one teaspoonful of cod liver oil. The only food commonly used by children which contains appreciable amounts of vitamin D is egg yolk, and from a survey of eggs obtained in the open market in Toronto, it was found that it required approximately 14 egg yolks to furnish the equivalent of one teaspoonful of cod liver oil (5). E. V. McCollum has drawn attention to the fact that there are no less than 37 individual food elements which must be supplied in adequate amounts for the development and maintenance of optimal health. It is not impossible that a lack of vitamin D, which is one of these 37 food elements, would impair the health of the child, and this impairment might show itself in an increase in tooth decay. Accordingly, the investigation was planned to show whether this lack of vitamin D had any effect on the development of tooth decay.

[1] From report presented at Symposium on Primary Teeth held at Second Biennial Meeting of the Society for Research in Child Development in Washington, October 1936.

[2] From Department of Pediatrics, University of Toronto.

Children living in an institution were observed over a period of one year. Their diet during this time supplied all the food elements ordinarily considered necessary with the exception of vitamin D. The children in the institution were divided into two groups. One-half continued on the standard diet, while to the diet of the other half was added vitamin D daily, the administration of this being facilitated through its incorporation in a small biscuit. At the beginning and at the end of the year a careful dental examination was made which included not only hard tissue examination but also bite-wing x-rays on every child. Final examinations were recorded without the dentists having any idea as to which group the children belonged. When the results were tabulated, it was found that in the group given the standard diet, which is deficient in vitamin D, the incidence of caries in the deciduous teeth was more than double that found in the other group of children receiving exactly the same diet but with added vitamin D (Table 1).

TABLE 1

Incidence of Caries

Average Number of Cavities per Child in Deciduous Teeth

	CONTROL GROUP (75 Children)	VITAMIN D GROUP (87 Children)
Non-Progressive	3.0	4.67
Slightly Progressive	0.05	0.19
Markedly Progressive	0.7	0.26
New Cavities	0.46	0.22

It is of interest to consider for a moment the pathological process involved in tooth decay. In tooth decay, the infecting organism enters the tooth from its surface. This entrance is probably accomplished through a local injury or defect of the hard enamel of the tooth. A local injury may be produced by acid from acid-forming bacteria. The well-known work of Bunting and his co-workers of Michigan indicates that the Lactobacillus acidophilus organism is the important factor in this injury. In a recent study reported from this clinic (6), we have shown a correlation between the presence of Lactobacillus acidophilus in the mouth of children and the presence of active tooth decay. The Michigan group of workers have shown that when sugar is fed, the growth of this bacterium is facilitated. It is believed that sticky particles of food containing large amounts of sugar become lodged over a certain area of the tooth. This forms a most excellent culture medium for the growth of the Lactobacillus acidophilus, which accordingly develops in small circumscribed areas, where the sticky particles are kept in continuous contact with the tooth. As the organism develops, it produces acid which can etch and injure the surface of the enamel, comparable in a way to a cut or injury to the skin. Through this injured area organisms proceed down the interprismatic cementing substance of the enamel, and thus tend to disintegrate it. As the infection proceeds further into the tooth, it reaches the more vascular dentin layer of the tooth with resultant liquefaction of the tissue and the production of the tooth cavity with which most of us are unfortunately quite familiar.

With this knowledge of the pathological process of tooth decay, how can it be

prevented by dietary means? Tooth decay can be prevented by - (a) The reduction of carbohydrate in the diet in the form of sugar. This removes a favorable medium for the growth and retention of acid-producing organisms (Lactobacillus acidophilus) in the mouth. (b) The administration of a diet built up around milk, meat, eggs, vegetables and fruit, with added vitamin D, which will tend to result in optimal health. Whether this diet acts by increasing the resistance of the tooth itself, or by changing the physical, chemical or bactericidal characteristics of the saliva, is not known. The fact remains, however, beyond any doubt, that the administration of this type of diet with its comparatively low sugar content does decrease tooth decay and tends to develop normal healthy teeth.

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IDENTIFICATION BY YOUNG CHILDREN OF DIFFERENTLY ORIENTED VISUAL FORMS

SIDNEY M. NEWHALL[1]

INTRODUCTION

A distinction has been made between visual shape and visual form (2). The stimulus essential for shape has been considered to be a differential light distribution, the perception of shape depending, merely, on unequal stimulation of different retinal parts. Perception of form qua form would not be present unless discrimination of the given figure persisted regardless of its orientation in the normal plane. Bingham trained his chick to discriminate an erect triangle from a circle, but when the triangle was inverted the chick could no longer discriminate it from the circle (1). This was an instance of shape but not form perception.

Various differentiae of form per se have been offered (7), but independence of rotation of the positive stimulus has remained a criterion of peculiar interest in animal and child experiments. As noted above, the chick, Gallus domesticus, failed to satisfy this criterion of form perception, and the same seems to have been true of the tortoise, Clemmys japonica (9). On the other hand, the crow, Corvus Americanus, is reported to have suffered inversion of the triangle without disturbance of behavior (3). Discrimination of the white rat broke down on rotation of the figure, though after prolonged training with the figure in 24 different positions the more general capacity to respond to any angular position had been acquired (6). Chimpanzees satisfied the rotation requirement completely by reacting correctly without further practice (7). The same was true of two year old children (7, 10).

Long before the recent interest in the rotation experiment, however, there was a variety of evidence pointing to early form perception in children. Since Preyer's work (12), investigators occasionally have been struck by the frequent mirror-writing of children learning to write, the equanimity with which young children observe books and pictures sideways or even up-side-down, the inversions and rotations found in their drawings and in their attempted copies of divers visual materials (13), or in general, by an apparent indifference among them to abnormal orientations of visual stimuli.

Such observations suggest a greater sensitivity to figure itself than to position, or in Bingham's terms, to form rather than shape. This, together with the impressive evidence by Gellermann for form perception in chimpanzees and children, and the great emphasis on form by the Gestalt psychologists, has favored a view that form is fundamental if not native. On the other hand, the evidence for shape but not form discrimination in lower animals suggests that form is a higher level integration or a function of learning. Field's rat experiment points toward a learned character for form (6).

[1] From the Child Institute of the Psychological Laboratory, the Johns Hopkins University.

The present study is an attempt to devise a more sensitive form of the rotation experiment for the purpose of investigating this problem in children. If the method were made sufficiently sensitive it was felt that perception of form might be found to be a function of age, training, or some other genetic variable.

Attention is here confined to horizontal and vertical reversals, partly because these are particularly interesting positions. Hanfmann, for instance, found that 4 to 7 year old children copied the positions of figures most accurately when the latter were horizontally or vertically oriented (8). There is the physiological fact that the retinas and projection areas are functionally divided vertically. There are, too, Stratton's and Ewart's well-known experiments involving both left-right and top-bottom reversals (4, 5, 14).

PROCEDURE

The principal apparatus employed was the Bailey visual perception test material (11). This consists of a series of twenty acuity charts including nothing but concrete and geometrical figures, and therefore requiring no reading ability. The child is seated ten feet from the chart. He has on a table before him an inclined tray on which may be placed cut-out block-figures like any of those printed in the charts.

The procedure is to expose a chart on the wall after about five figures have been placed at random on the child's tray. These figures include the block corresponding to the charted figure. Then the child's task is to look at the wall chart and the tray, and indicate the figure in the tray which is the same as the test-object on the wall. This procedure may be repeated with smaller and smaller test-objects until normal acuity has been demonstrated or the resolution threshold has been reached.

For present purposes, several variations were made in the administration of this test: (1) Eight of the block-figures, varying in size and form, were sometimes presented in the tray inverted, either left-for-right or top-for-bottom. This was for the purpose of discovering any noticeable effect of the inversion on identification. These experimental or test figures were: chair, horse, candle, boat, rabbit, child, dog, parallelogram. (2) The child indicated identification of all figures by handing them to the experimenter. (3) The experimenter handed the test figures back inverted, in order to see whether such presentation would influence the child's replacement of the figures in the tray. If it did, there would be evidence that the child noticed the inversion. (4) All observing was with binocular vision and controlled illumination. (5) Each child served in four series, reacting to all twenty test-objects in each series. Usually two series could be completed in a single session. The serial order was varied with different subjects.

The experimental variations in the several series were: Series 1, normal; Series 2, test figures left-right reversed in tray; Series 3, normal; Series 4, test figures top-bottom reversed in tray. In all series the test figures were returned to the subject reversed; in Series 1 and 2 the reversal was left-right, in Series 3 and 4 it was top-bottom.

TABLE I

FORM IDENTIFICATION IN RELATION TO ORIENTATION AND AGE OF SUBJECT

Age of subject	60	55	50	45	40	35	Total
Left-right reversed	8	8	38	28	22	8	112
Normal orientation	8	8	37	28	21	7	109
L-r rev./Normal	1.00	1.00	1.03	1.00	1.05	1.14	1.03
Top-bottom reversed	8	8	36	31	25	6	114
Normal orientation	8	8	36	31	29	7	119
T-b rev./Normal	1.00	1.00	1.00	1.00	.86	.86	.96
Total reversed	16	16	74	59	47	14	226
Total normal	16	16	73	59	50	14	228
Tot.rev./Tot.nor.	1.00	1.00	1.01	1.00	.94	1.00	.99

NUMERICAL RESULTS

Identification of reversed figures. Tables I and II summarize the data on the influence of reversal on identification. Table I is arranged to show a relation between age of subject and frequency of identification. Age in months at test-time is given in nearest multiples of five in the first row. The second row contains the frequencies of correct identifications of the left-right reversed figures while the third row gives the corresponding values for the normally oriented figures. The next row shows the ratios of the reverse to the normal values. These ratios are not far from unity, a fact which indicates that left-right reversal does not interfere with identification. The next three rows contain the corresponding results on the influence of top-bottom reversals, and again the ratios are indicative of little or no interference. The final three rows of this table compare the totals with like result.

Comparison of the successive columns of Table I shows no trend away from unity, and therefore no functional relationship between age of subject and influence of reversal on identification.

Table II is arranged in the same way as Table I except that age has been replaced by size of test-object, as the independent variable. Size is given in the first row in terms of the standard resolution of normal vision. This standard is represented by unity. Thus size 3 is relatively large and could be normally discriminated at three times the distance employed; size 2 at twice the distance, and so on. Comparison of the columns of this table reveals no relationship between size of test-object and influence of reversal on identification.

Replacement of reversed figures. Tables III and IV summarize the numerical data on the influence of reversed returns by experimenter to subject, on normality of replacement by subject. Handing the figure back to the child reversed meant that he would have to turn it himself in order to replace it in the tray

TABLE II

FORM IDENTIFICATION IN RELATION TO ORIENTATION AND SIZE OF TEST-OBJECT

Size of test object	3	2	1.5	1.25	1	Total
Left-right reversed	15	29	14	28	26	112
Normal orientation	15	29	11	28	26	109
L-r rev./Normal	1.00	1.00	1.27	1.00	1.00	1.03
Top-bottom reversed	16	31	11	27	29	114
Normal orientation	16	32	14	30	27	119
T-b rev./Normal	1.00	.97	.79	.90	1.07	.96
Total reversed	31	60	25	55	55	226
Total normal	31	61	25	58	53	228
Tot.rev./Tot.normal	1.00	.98	1.00	.95	1.04	.99

in normal position. The voluntary act by the child of turning the figure would suggest that he was aware of the reversal, for otherwise he could scarcely be expected to make the correction. If the correction was not made there would be less certain evidence that the reversal was not recognized.

TABLE III

NORMAL REPLACEMENT IN RELATION TO ORIENTATION AND AGE OF SUBJECT

Age of subject	60	55	50	45	40	35	Total
Left-right reversed							
Normal replacements	5	9	15	16	7	2	54
Total replacements	16	16	75	56	43	15	221
Normal/Total	.31	.56	.20	.29	.16	.13	.24
Top-bottom reversed							
Normal replacements	16	16	68	55	39	13	207
Total replacements	16	16	72	62	54	13	233
Normal/Total	1.00	1.00	.95	.89	.72	1.00	.89

Table III is arranged to show a relation between age of subject and normality of replacement. The first row gives age to the nearest multiple of five months. The second row shows the frequencies of normal replacements when the test-figure was handed to the child left-right reversed. The third row shows the frequencies of total replacements. In the next are given the ratios of the normal to the total replacements, and they are all seen to be small. This means that the children usually replaced the figures left-right reversed after having received them left-right reversed. The suggestion is that the child was usually not definitely aware of these left-right reversals.

The lower half of the table exhibits the corresponding data on top-bottom reversals and here the ratios are found to be relatively large. This means that the subjects usually replaced the figures normally after having received them top-bottom reversed. The indication is that the child was aware of these top-bottom reversals.

There is no definite indication in Table III of a correlation between age of subject and influence of reversed return on correctness of replacement. Table IV shows no correlation between size of test-object and influence of reversed return.

TABLE IV

NORMAL REPLACEMENT IN RELATION TO ORIENTATION AND SIZE OF TEST-OBJECT

Size of test-object	3	2	1.5	1.25	1	Total
Left-right reversed						
Normal replacements	8	14	8	15	9	54
Total replacements	30	58	25	56	52	221
Normal/Total	.27	.24	.32	.27	.17	.24
Top-bottom reversed						
Normal replacements	24	57	22	53	51	207
Total replacements	32	63	25	57	56	233
Normal/Total	.75	.90	.88	.93	.91	.89

DISCUSSION

Equally accurate identifications of both the reversed and unreversed figures are indicated by the near-unit ratios of Tables I and II. Children from 3 to 5 years of age seem to have reacted immediately and regardless of shape to the particular test figures employed. But there are several reasons for not generalizing this result: (1) most of the test figures were presumably familiar to young children and might therefore have been abstracted from context by experience preceding the experiment. Rats have learned to discriminate form through training. (2) The age-range of the subjects may well have been too short to discover some real form genesis. (3) The subjects' Aufgabe was not improbably a "discriminate form" Aufgabe. Had it been a "discriminate position" Aufgabe, shape rather than form might have been favored. Suitable controls could be exerted on such points.

The reason for having the subject replace test-figures which had been handed to him reversed was to provide behavioral evidence for a distinction between identification of reversed figures and awareness of reversal. In the effort to design a sensitive method, it seemed interesting to discover whether or not identification is independent of awareness of reversal.

Awareness of the top-bottom reversals was clearly demonstrated by the high proportions of corrections. Indeed, there is every indication that these values

would have been maximal except for cases of children playing with blocks known to be up-side-down, and the case of a child who said she returned the blocks reversed "because we do in Sunday School." Frequently a child would make an effort to correct a reversed block in the tray. Frequently, comments would indicate definite awareness of reversals. "Put it up-side-down again." "I want to put it this way." "That's up-side-down." "But the chair isn't up-side-down in the picture." Often the child reversed the block handed to him in a very obvious way, and it seemed clear that he was making intentional correction. Occasionally, the correction was made quite emphatically or impatiently and the experimenter could feel the block being twisted as it left his hand.

The evidence for unawareness of the left-right reversals consists in the low proportions of corrections. These proportions might have been even lower if the experimenter could offer the piece in such a way as to avoid all accidental corrections. Almost always, the pieces seemed to be returned at random insofar as left-right orientation was concerned. There was no impatient twisting of the piece, and only one comment to suggest that a subject had noticed a left-right reversal. In numerous cases where top-bottom reversals were corrected, they remained uncorrected left-right. In brief, there was little to indicate detection of left-right reversals.

Nevertheless, the evidence can not be considered conclusive because the child may have noticed reversals but not have bothered to correct them. There was really nothing strikingly 'wrong' in figures facing either to the left or right. Up-side-down figures, on the other hand, defied the basic gravitational orientation. Furthermore, there were two subjects who did evidence deliberate correction of left-right reversals. One (56 months) remarked that the boat faced the wrong way in the tray and corrected it. She also made correct replacements of the chair, horse, and rabbit. The other (52 months) also corrected several of these reversals. She returned one piece up-side-down (smiling.) These results from older children suggest the possibility that detection of the left-right reversals may be a function of age or training. A greater age-range should be studied.

SUMMARY

1. A method for investigating the form-shape distinction has been described and applied in a preliminary study.

2. The 16 subjects, varying in age from 3 to 5 years, appeared to identify the particular visual figures employed about as quickly and correctly with reversed as with normal orientation.

3. Accuracy was independent of age, over the short age-range available.

4. Accuracy was independent of size of test-object, even down to the standard resolution of 20-20 vision.

5. There was also some evidence that accuracy was independent of definite awareness of reversals.

6. There were some doubtful indications, which should be investigated further, of a possible relation between detection of left-right reversals and age of subject.

7. The provisional interpretation for the limited data is that spatial orientations of the types investigated play no necessary role in the young child's identifications of plane visual forms. This interpretation evidently favors the Gestalt position. But more work with younger children and other appropriate controls might well disclose a genetic development.

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A NEW EIDETIC PHENOMENON

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Despite the fund of eidetic literature that is at hand to date, it has failed to enlist any widespread and active interest among American psychologists. Belonging, as it does, to the category of special abilities, eidetic imagery has been relegated to a remote corner of research.

However, the eidetic field is fertile with theoretical implications and experimental possibilities which should not be overlooked. The basic facts that the eidetic image is externalized or "seen" with apparently perceptual objectivity, and that under certain conditions it "obeys" or is psychologically modified by certain laws of optics, by the physiological conditions of the retina, and by the spatial position and lability of the screen open up avenues of approach for the investigation of dynamic visual processes as well as for methods of determining the precise nature of the eidetic image itself. The latter problem beckons our immediate interest, in view of the important bearing it must have upon fundamental psychological theory. What, then, is the mechanism of the eidetic image?

In a preliminary attack upon this problem, we have uncovered what seems to be a new and significant phenomenon, namely, that an eidetic image can be inverted phenomenally by rotating the screen 180 degrees. This fact suggested the presentation of inverted pictures, for which eidetic images were obtained. Rotation of the screen righted the images for the Ss. The latter variation of the rotation phenomenon brought out the fact that, although the Ss were unable to interpret the visually presented inverted pictures, the perceptual meaning dawned in the eidetic phase after the eidetic images had been projected and after the screen had been rotated 180 degrees.

To test this phenomenon more rigidly, a complicated picture was used. A magazine advertisement was presented in inverted position to several adults, none of whom succeeded in perceiving what it was. Upon rotation of the picture, the variegated mass of daubs and streaks was easily recognized as a birthday cake. This inverted picture was used in succeeding rotation experiments with eidetic boys, and in every case the meaning of the picture became clear only in the eidetic phase, after the screen had been rotated 180 degrees. It is also curious to note that a large card with the word "FRIGIDAIRE" boldly printed thereon was presented visually in inverted position to a nine year old eidetic boy. An inverted eidetic image was obtained, but it could not be interpreted. Upon rotation of the screen, the boy recognized the image as a word which he could not pronounce but which he promptly spelled out. He reported that one letter, "G," had faded out, so that he could not perceive what it was.

Have we here a phenomenon of pure suggestion? An effort was made to control suggestion by verbal counter-suggestion, but the eidetic image clung faithfully to the projection screen. With a stationary screen, the Ss could rotate their

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images slightly, but all rotations were below 90 degrees. More rigid investigations to determine the suggestion factor are now in progress.

This phenomenon is important not only for eidetic research; it also offers a promising device for investigating Gestalt aspects of perception.